Bill Campbell

NHB 5300.1A

OFFICE OF MANNED SPACE FLIGHT

APOLLO PROGRAM

JULY 1966

APOLLO RELIABILITY AND QUALITY ASSURANCE PROGRAM PLAN

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Washington, D.C. 20546

PREFACE

Date: July, 1966

This document is an official release of the Apollo Program Office, and has been prepared in accordance with the requirements of the Apollo Program Development Plan, M-D MA 500. This revised edition supersedes the issue dated October 1965.

The changes and additions to this document reflect current operations, as the result of coordinated actions between Center and Apollo Program Offices. Significant changes which have been made are:

- Revision of paragraph 2.6 to expand Apollo Failure and Defect Reporting.
- Addition of paragraphs 2.7 and 2.9 to cover Apollo Single Failure Points, and Apollo Flight Readiness Reviews.
- Revision of paragraphs 4.2 and 4.3 to clarify Mission Reliability and Center Reliability Analyses.
- Addition of Section 8 covering Identification for Traceability.
- Addition to Section 9 covering Nonconforming Material Control.

Requirements should be considered for implementation where they are not now being carried out. The Center Program Offices should compare the benefits to be derived with the problems of implementation. Where Center Program Offices are unable to implement certain requirements, the deviation should be made known to the Director, Apollo Program Office, including the identification of, need for, and extent of the deviation.

Samuel C. Phillips
Major General, USAF
Director, Apollo Program

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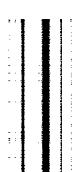

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Section 1: INTRODUCTION

1.1 PURPOSE

The purpose of the Apollo Reliability and Quality Assurance (R&QA) Program Plan is to set forth the overall Apollo R&QA requirements and to provide procedures for implementing and evaluating the Apollo R&QA Program.

1.2 SCOPE

The Apollo R&QA Program Plan, as set forth in this publication:

a. States the R&QA policies, requirements, and procedures applicable to the Apollo Program;

b. Identifies the means whereby the R&QA policies and requirements are implemented in the Apollo Program;

c. Establishes requirements for provisions to be included in the Center Apollo R&QA plans;

d. Provides guidelines for consistent implementation of applicable NASA-wide R&QA documents, and development of additional standards and procedures, as needed; and

e. Establishes requirements for reporting, auditing, and evaluating progress at all levels to ensure that a check and balance is provided at each level (i.e., Apollo Program Office - R&QA to Centers, Centers to contractors, and contractors to subcontractors).

1.3 AUTHORITY

a. The NASA Projects Approval Document (PAD) for Apollo (Code 92-900-000) establishes NASA approval of the Apollo Program and states the following R&QA requirements:

> "Reliability, Quality Assurance and Inspection programs will be established in accordance with the provisions of NPC 250-1, NPC 200-1A, NPC 200-2, and NPC 200-3, as appropriate, in-house and/or at the sytem prime and subcontractors to satisfy the overall mission requirements; and a plan for independent assessment of reliability and quality will be established to assure that the mission requirements can be met. The status of these activities will be reported separately or as a part of the system periodic progress reports."

b. The Apollo Program Development Plan (PDP), M-D MA 500, Section 10, sets forth the broad policies, requirements, disciplines, and procedures for Apollo R&QA.

1.4 APPLICABILITY

a. The organizational elements participating in the Apollo Program will adhere to the provisions of this publication. The provisions specified herein will be assessed for their impact on the on-going program. The Apollo Program Director will be notified by the Center of any deviations that are considered necessary and the basis for such deviations.

b. This publication is applicable to the following Apollo Program elements:

(1) Spacecraft.

(2) Saturn IB.

(3) Saturn V.

(4) Launch Vehicle Engines.

(5) Vehicle and Launch System Mission Essential Ground Support Equipment (e.g., ACE, MSE, ESE) and Ground Operations Support Systems (GOSS).

(6) Crew System Equipment.

(7) Mission Experiment Equipment.

1.5 APPLICABLE DOCUMENTS

a. Documents applicable to the Apollo R&QA Program are set forth in Appendix A.

b. Any inconsistencies found to exist between this document and the referenced documents should be brought to the attention of the Apollo Program Office - R&QA.

1.6 ABBREVIATIONS

A list of abbreviations and codes used in this publication is set forth in Appendix B.

1.7 GLOSSARY OF TERMS

A glossary of terms used in this publication is set forth in Appendix C.

Section 2: RELIABILITY AND QUALITY ASSURANCE REQUIREMENTS

2.1 GENERAL

The Apollo R&QA Program is based on a series of requirements or activities which take place during the various hardware program phases, all directed toward meeting the Apollo performance requirements established in the Apollo Program Specification. Section 2 of this document sets forth the Apollo hardware R&QA requirements; the NASA Headquarters and Apollo Program Office documents which describe these requirements; and an outline of the basic R&QA Program implementation activities. Details of the R&QA Program implementation activities are described in subsequent sections.

2.2 R&QA REQUIREMENTS FOR PHASED HARDWARE DEVELOPMENT

2.2.1 GENERAL. R&QA Offices have the responsibility for assuring that adequate R&QA requirements are established, and for accomplishment of, or participation in or verification of the accomplishment of, these requirements. The following is a listing of R&QA requirements by hardware development phase. Key requirements are also depicted in Figure 2-1. The R&QA requirements are shown under the phase in which they are expected to be accomplished; however, some items may be initiated earlier or later depending upon the status of their particular hardware development. All the requirements are appropriate to the major hardware systems of the Apollo Program. It is recognized that certain types of hardware and current phases of development may require some adjustment in accomplishing all these requirements; therefore, the Center Apollo Program Office is responsible for selecting and implementing those requirements necessary to achieve satisfactory performance of the hardware over which it has cognizance, within the restrictions of Apollo Program Office Directives. References noted in parentheses indicate documents where detailed requirements can be found.

2.2.2 STUDY/DEFINITION PHASE REQUIREMENTS

a. Development of preliminary R&QA program plans. (NPC 250-1, NPC 200-2)

b. Development of preliminary mathematical model and reliability predictions. (NPC 250-1)

c. Establishment of reliability and safety goals and other R&QA requirements in preliminary specifications. (NMI 5320.1, NMI 5330.1, NPC 500-1)

d. Analysis of feasible alternatives and factors which could be major problems in achieving goals. (NPC 250-1)

2.2.3 DESIGN PHASE REQUIREMENTS

a. Development and approval of R&QA program plans. (NPC 250-1, NPC 200-2)

b. Development of system/functional logic/block diagrams. (NPC 500-1, NHB 7500.1, NPC 250-1)

c. Use and analysis of mission profile for mathematical model. (M-D MA 500, M-DE 8000.005)

d. Development of preliminary failure mode, effects, and criticality analyses. (NPC 250-1)

e. Development of mathematical models and reliability predictions. (NPC 250-1, RA 006-007-1)

f. Performance of trade-off studies involving reliability. (NPC 250-1)

g. Apportionment of reliability goals to equipments and components. (NPC 250-1)

h. Establishment of reliability requirements in specifications. (NPC 500-1)

i. Establishment of quality assurance requirements in specifications. (NPC 500-1, NPC 500-10)

j. Determination of need for redundancy (equipment, human, spare parts). (NPC 250-1, NPC 500-1)

k. Determination of need for maintainability. (NPC 250-1, NPC 500-1, NHB 7500.1)

l. Design to minimize human-induced failures. (NPC 250-1, NHB 7500.1)

m. Selection of parts with established reliability, and related manufacturing sources. (NPC 250-1, NHB 7500.1, Section 7 of this document)

n. Designation of parts to be identified by serial or lot numbers; determination of traceability requirements. (NPC 200-2, NPC 500-1, Section 8 of this document)

o. Determination of time and duty cycle critical articles. (NPC 250-1, NHB 7500.1)

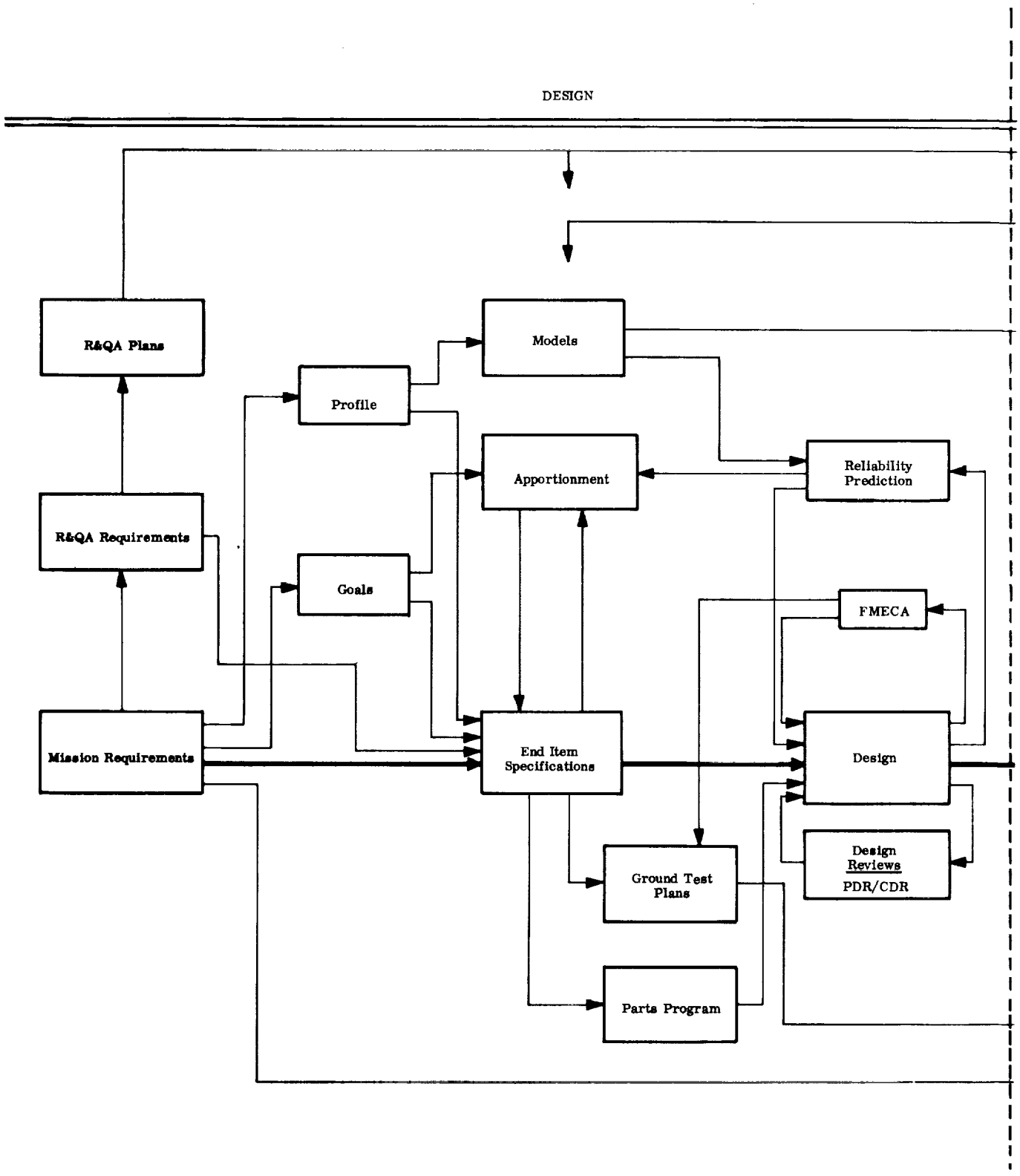
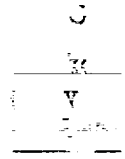
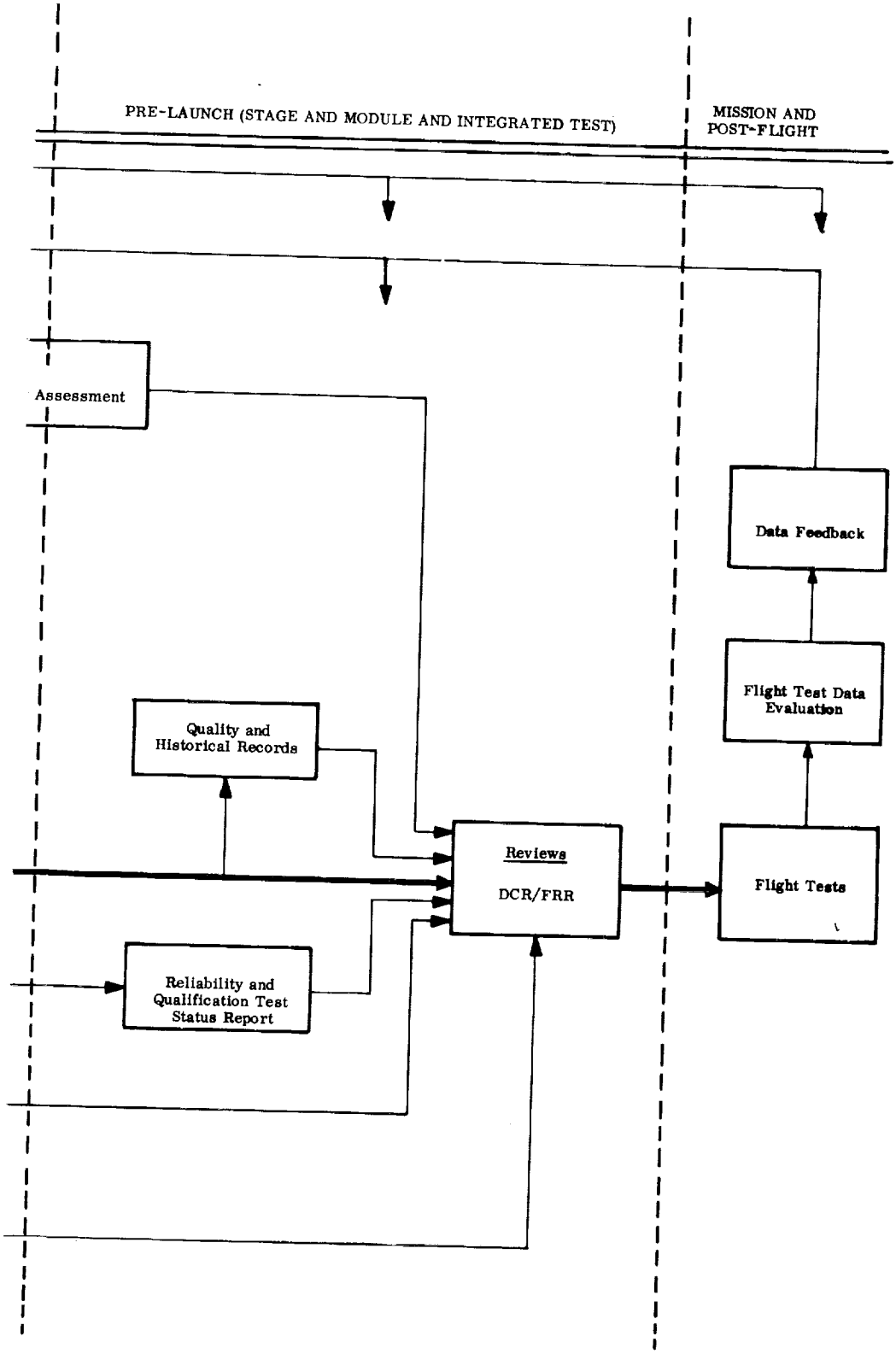
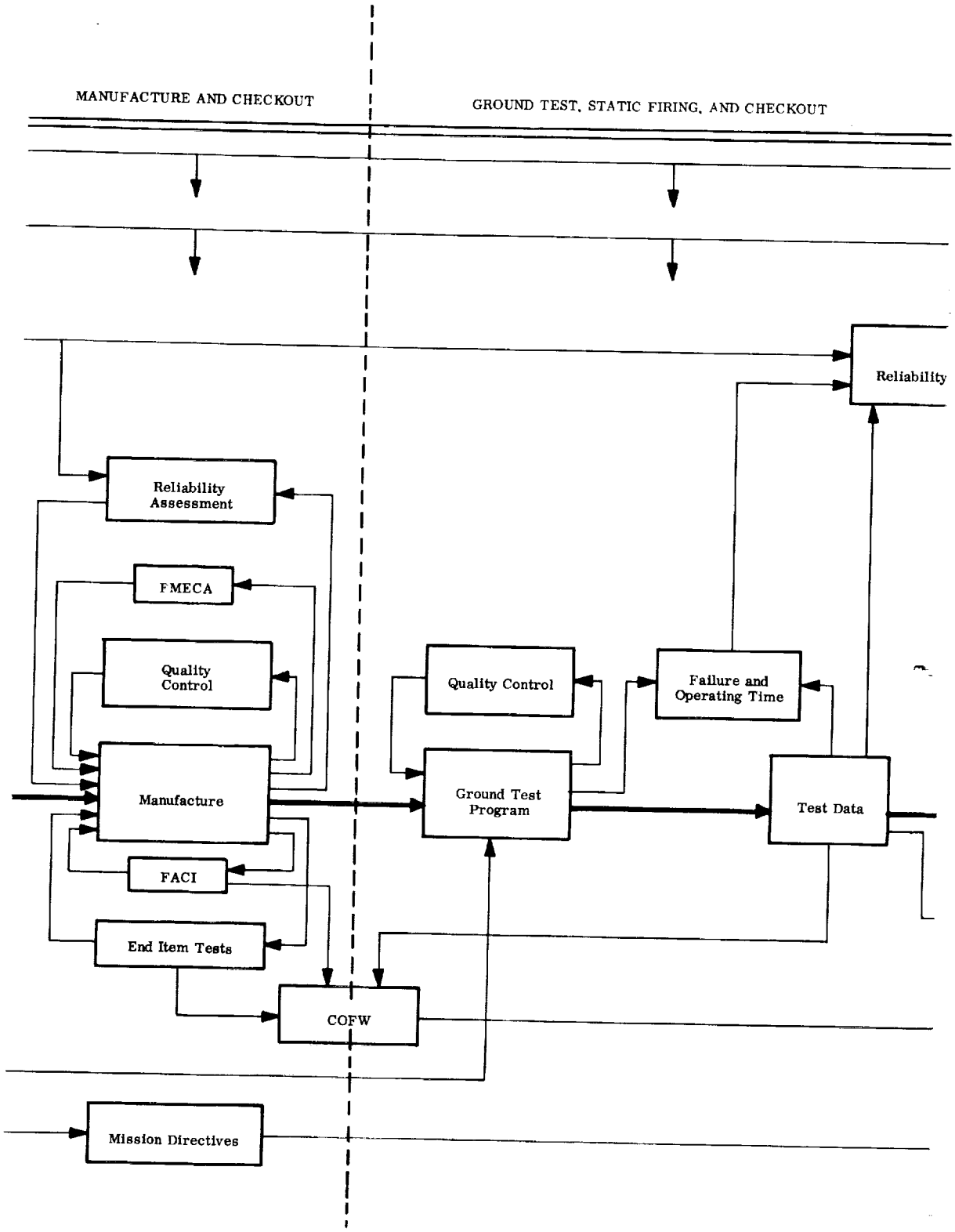


Figure 2-1. R&QA Requirements for Phased Hardware Development




PRE-LAUNCH (STAGE AND MODULE AND INTEGRATED TEST)
MISSION AND POST-FLIGHT
Assessment
Data Feedback
Flight Test Data Evaluation
Quality and Historical Records
Reviews
DCR/FRR
Flight Tests
Reliability and Qualification Test Status Report


MANUFACTURE AND CHECKOUT
GROUND TEST, STATIC FIRING, AND CHECKOUT
Reliability
Reliability Assessment
FMECA
Quality Control
Manufacture
FACI
End Item Tests
COFW
Quality Control
Ground Test Program
Failure and Operating Time
Test Data
Mission Directives

p. Identification of quality characteristics. (NMI 5330.1, NPC 200-2)

q. Development of reliability evaluation program as part of the reliability program plan. (NPC 250-1)

r. Development of procedures to control purchased and fabricated parts, processes, assemblies, and maintenance and calibration of inspection, measuring, and test equipment. (NPC 200-2, NPC 500-1, RA 006-011-1A)

s. Development of detailed procedures and conformance criteria for receiving inspection, in-process inspection and end-item test and acceptance inspection. (NPC 500-1, NPC 500-10, NPC 200-2, NPC 250-1)

t. Establishment of a system and initiation of systematic reporting of failures, analyses, corrective actions, and verification testing. (NPC 250-1, NPC 200-2, NPC 500-10, Paragraph 2.6 of this document)

u. Participation in development of overall test program. (NPC 500-1, NPC 500-10, NPC 250-1)

v. Participation in performance of reliability demonstration and qualification tests. (NPC 500-1, NPC 500-10, NPC 250-1, NPC 200-2)

w. Participation in performance of reviews. (NPC 500-1, NPC 250-1, M-D MA 500)

x. Participation in the establishment of and exercise of configuration management procedures. (NPC 500-1)

2.2.4 MANUFACTURING AND CHECKOUT PHASE REQUIREMENTS

a. Provision for training and maintaining certification of operators and inspectors. (NPC 200-2, NPC 200-1A, NMI 5330.4)

b. Performance of receiving and in-process inspection. (NPC 200-2, NPC 200-3)

c. Exercise of configuration management requirements. (NPC 500-1)

d. Participation in Material Review Board actions. (NPC 200-2, Section 9 of this document)

e. Designation of Quality Stamping. (NMI 5330.2)

f. Participate in performance of reviews. (NPC 250-1, NPC 200-2, M-D MA 500)

g. Updating of failure mode, effects, and criticality analyses. (NPC 250-1)

h. Updating of system/functional logic/block diagrams. (NPC 500-1, NPC 250-1)

i. Updating of mathematical models and performance of reliability assessments. (NPC 250-1, RA 006-007-1)

j. Verification of performance of systems, subsystems, components and parts qualification tests. (NPC 500-1, NPC 500-10, NPC 250-1, NPC 200-2)

k. Verification of performance of reliability demonstration tests on critical systems, subsystems, components, and parts. (NPC 500-1, NPC 500-10, NPC 250-1)

l. Verification of performance of end-item acceptance tests. (NPC 200-2, NPC 500-1, NPC 500-10)

m. Performance of systematic reporting of failures, analyses, corrective actions, and verification testing. (NPC 250-1, NPC 200-2, NPC 500-10, Paragraph 2.6 of this document)

n. Initiation and maintenance of equipment logs. (NPC 250-1, NPC 500-1)

o. Performance of factory Government acceptance - sign off DD 250. (NPC 500-1, NPC 500-10, NPC 200-2)

p. Preparation of Certificates of Flight Worthiness. (NPC 500-10)

2.2.5 GROUND TEST, STATIC FIRING AND CHECKOUT PHASE REQUIREMENTS

2.2.4.a a. Performance of receiving and in-process inspection. (NPC 200-2, NPC 200-3)

b. Exercise of configuration management requirements. (NPC 500-1)

c. Verification of performance of systems, subsystems, components and parts, qualification tests. (NPC 500-1, NPC 500-10, NPC 250-1, NPC 200-2)

d. Verification of performance of reliability demonstration tests on critical systems, subsystems, components, and parts. (NPC 500-1, NPC 500-10, NPC 250-1)

e. Verification of performance of end-item acceptance tests. (NPC 200-2, NPC 500-1, NPC 500-10)

f. Verification of performance of pre-use checkout (ground support equipment) and pre-launch checkout (flight systems). (NPC 500-10)

g. Performance of systematic reporting of failures, analyses, corrective actions and verification testing. (NPC 500-10, NPC 250-1, NPC 200-2, Paragraph 2.6 of this document)

h. Maintenance of equipment logs. (NPC 250-1)

i. Endorsement of Certificates of Flight Worthiness. (NPC 500-10)

j. Participation in revision of ground test plan based on flight experience and failure analyses. (NPC 500-10, NPC 200-2, NPC 250-1)

k. Review of software procedures.

l. Review and monitor test and checkout procedures.

2.2.6 PRE-LAUNCH PHASE REQUIREMENTS (STAGE AND MODULE AND INTEGRATED TEST)

a. Performance of receiving and in-process inspections. (NPC 200-2, NPC 200-3)

b. Verification of test of all modifications, repairs, and rework made at launch site. (NPC 500-10, NPC 250-1, NPC 200-2)

c. Verification that the space vehicle hardware end items are described by officially released engineering and that all required engineering changes after hardware delivery from the factory have been installed in the hardware. (NPC 500-1)

d. Verification of performance of system-integrated tests and simulated countdown. (NPC 500-10)

e. Verification and updating of equipment logs, narrative end-item reports, and qualification test status. (NPC 250-1, NPC 200-2, NPC 500-10)

f. Review and assessment of pre-flight troubles; constraints, waivers, deviations, modifications, discrepancies; and, adequacy of corrective actions. (NPC 250-1, NPC 200-2)

g. Verification of final mission profile. (M-D MA 500)

h. Review, from reliability standpoint, of the mission operational ground rules, and contingency plans concerning countdown, holds, scrubs, aborts, and alternative missions. (M-D MA 500)

i. Performance of reliability assessment for each flight. (NPC 250-1)

j. Provision of final inputs to FRR. (APO PD No. 8)

k. Review of software procedures.

l. Review and monitor pre-launch procedures.

2.2.7 POST-FLIGHT PHASE REQUIREMENTS

a. Participation in evaluation of flight test data. (NPC 500-10, APO PD No. 19)

b. Comparison of results with those predicted from design analysis and ground test. (NPC 500-10)

c. Assurance of correction of critical flight failures on follow-on flights. (Paragraph 2.6.3 of this document)

d. Review of hardware modifications for effect on reliability improvement on next flight. (NPC 250-1, NPC 500-1)

e. Participate in revision of ground test plan based on analysis of flight data. (NPC 500-10)

2.2.8 REQUIREMENTS APPROPRIATE TO ALL PHASES

a. Performance of data collection and analysis. (NPC 500-1, NPC 500-10, NPC 200-2, NPC 250-1)

b. Preparation of R&QA reports, as required by contract or directive. (NPC 500-1, NPC 500-10, NPC 200-2, NPC 250-1)

c. Development and implementation of Training and Motivation Program. (NPC 250-1, NPC 200-1A, NPC 500-1, NPC 200-2)

d. Performance of R&QA audits. (NPC 250-1, NPC 200-2, Section 6 of this document)

2.3 REQUIREMENTS IN NASA DOCUMENTS

2.3.1 GENERAL. The requirements listed above are amplifed and developed in NASA Headquarters and Apollo Program Office documents, which are described below. The relationships of these documents and their requirements to R&QA requirements are given in Figure 2-2, "Program Documentation/Requirements Structure."

2.3.2 NASA MANAGEMENT INSTRUCTIONS

a. NASA Management Instructions 5320.1 and 5330.0 are applicable to the Apollo Program. These instructions provide guidance for:

(1) Establishment of design reliability goals;

(2) Performance of detailed analysis of system reliability at appropriate points in the program from design through completion of the mission;

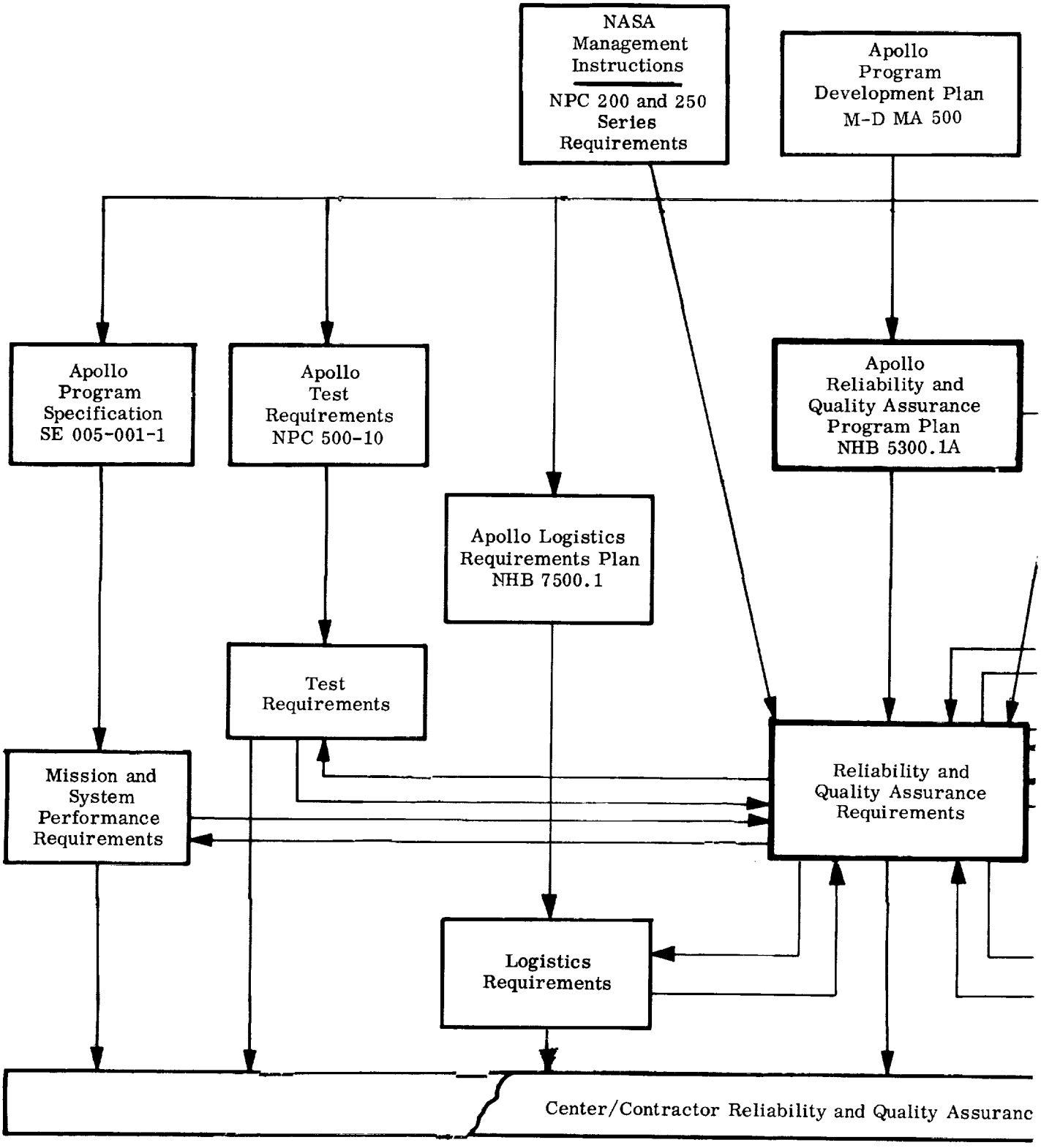
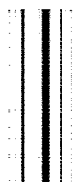
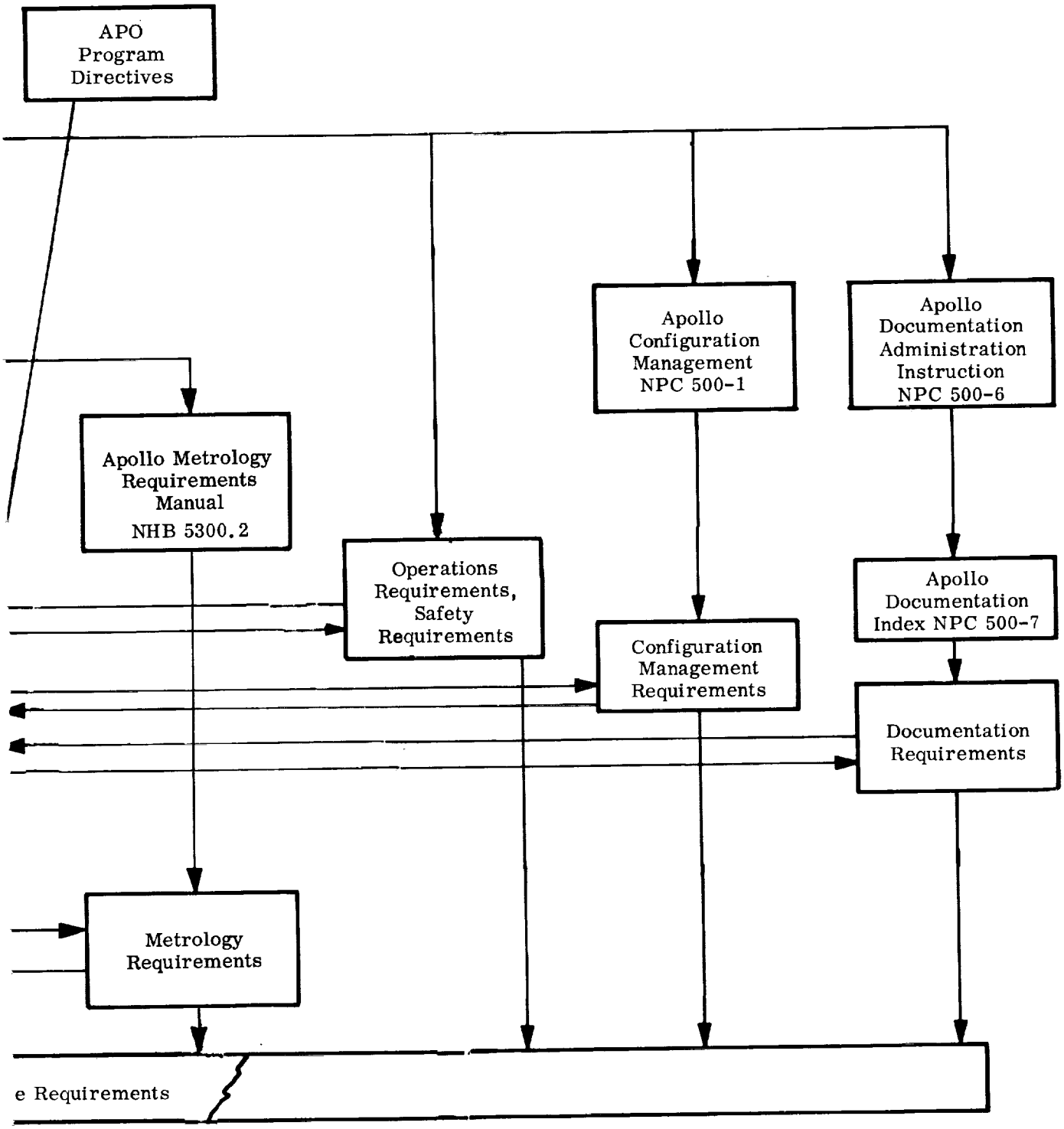


Figure 2-2. Program Documentation/
Requirements Structure




APO
Program
Directives
Apollo
Configuration
Management
NPC 500-1
Apollo
Documentation
Administration
Instruction
NPC 500-6
Apollo Metrology
Requirements
Manual
NHB 5300.2
Operations
Requirements,
Safety
Requirements
Apollo
Documentation
Index NPC 500-7
Configuration
Management
Requirements
Documentation
Requirements
Metrology
Requirements
e Requirements

2-9/2-10

(3) Establishment of a testing program to demonstrate, insofar as practical, that system reliability can be achieved;

(4) Identification of quality assurance characteristics;

(5) Demonstration of conformance to standards;

(6) Establishment of data feedback for quality improvement.

b. NASA Management Instruction 5330.2, Quality Status Stamping Requirements, is applicable to the Apollo Program. This instruction establishes the policy, procedures, and the NASA quality status stamps required for indicating the quality status of NASA space systems, components, materials, and accompanying documents either procured from suppliers or developed in-house.

c. NASA Management Instruction 5330.4, Policies and Procedures for Recertification of Hand Soldering Personnel is applicable to the Apollo Program. This instruction establishes policies and procedures for recertification of agency and supplier personnel involved in hand soldering on NASA programs and obviates the requirement for recertification training at a NASA school as a requisite for recertification.

2.3.3 NASA RELIABILITY AND QUALITY PUBLICATIONS, NPC 250-1, NPC 200-2, and NPC 200-3

a. The provisions of NPC 250-1, Reliability Program Provisions for Space System Contractors, and NPC 200-2, Quality Program Provisions for Space System Contractors, constitute basic requirements for R&QA programs to assure the reliability and quality of Apollo space systems. The provisions of NPC 200-3, Inspection System Provisions for Suppliers of Space Materials, Parts, Components, and Services, constitute basic requirements for inspection systems to assure the quality of Apollo space materials, parts, components and services.

b. When invoked in NASA contracts, NPC 250-1, NPC 200-2, and NPC 200-3, or elements thereof, serve as requirements to Apollo contractors in the preparation of contractor reliability, quality, or inspection plans. (Ref: Section 3.0.)

c. In all cases, the Center Apollo Program Offices - R&QA are responsible for determining and interpreting NASA R&QA requirements for appropriate Apollo systems and hardware, and invoking these requirements in appropriate Apollo contracts and specifications in accordance with the procedures of NPC-400, NASA Procurement Regulations, NASA PR 1.50 and 1.51. The requirements of these documents also apply to Center in-house activities. Particular attention will be given to invoking those requirements which can provide effective utilization of resources to gain maximum benefit to the program.

2.3.4 NASA QUALITY PUBLICATION, NPC 200-1A

a. The provisions of NPC 200-1A, Quality Assurance Provisions for Government Agencies, constitute basic requirements for Government Agencies, either NASA or DoD, at contractor's plants performing inspection and quality assurance functions for NASA.

b. The Center Apollo Program Office - R&QA is responsible for delineating specific quality assurance and inspection functions to be performed by the Government Agency representatives in accordance with NPC 400, NASA Procurement Regulations, NASA PR 14.1, 14.2, and 14.50 and for invoking NPC 200-1A, where appropriate.

2.3.5 APOLLO PROGRAM DEVELOPMENT PLAN, M-D MA 500. The provisions of Section 10, Reliability and Quality Assurance, of the Apollo Program Development Plan, set forth R&QA requirements and disciplines applicable to the Apollo Program. In particular, reference is made to the requirement to use NPC 250-1, NPC 200-2, NPC 200-3, and NPC 200-1A, as provided above. Included are specific reliability and quality disciplines which are required during appropriate phases of the Apollo Program.

2.3.6 APOLLO PROGRAM SPECIFICATION, SE 005-001-1. The Apollo Program Specification contains technical requirements for the program as an entity. These requirements relate to:

a. Mission requirements identified and description of the program.

b. Program performance requirements.

c. Reliability requirements and goals.

d. Program quality assurance and testing requirements.

The provisions of this document establish the basic reliability requirements for the program from which detailed R&QA requirements are established by Center Apollo Program Offices - R&QA.

2.3.7 APOLLO PROGRAM CONFIGURATION MANAGEMENT MANUAL, NPC 500-1. The provisions of NPC 500-1, Apollo Program Configuration Management Manual, constitute the basic requirements to establish uniform configuration management methods and procedures which will accurately define all Apollo Program equipment at any point in time. Apollo R&QA program hardware activities at all levels will be based on configuration management techniques required by NPC 500-1.

2.3.8 APOLLO LOGISTICS REQUIREMENTS PLAN, NHB 7500.1. The Apollo Logistics Requirements Plan, NHB 7500.1, establishes the logistic requirements and assures their proper integration throughout the Apollo Program. The Apollo Program Office - R&QA will be responsible for assuring compliance with R&QA requirements incorporated in the Apollo Logistics Requirements Plan.

2.3.9 APOLLO DOCUMENTATION, NPC 500-6, NPC 500-7

a. NPC 500-6, Apollo Documentation Administration Instruction (ADAI), establishes policies, assigns responsibilities and prescribes management procedures for the identification, planning, selection, acquisition, control, scheduling, and minimization of essential documents required for the management of the Apollo Program. ADAI, Section 10, Exhibit A, defines the category of documents designated "Reliability and Quality Assurance." Apollo R&QA documentation and data activities will be conducted in accordance with the requirements of the ADAI.

b. NPC 500-7, Apollo Documentation Index (ADI), provides a list of documents required and authorized for use on the Apollo Program at all levels. It contains all recurring Apollo Program documents.

2.3.10 APOLLO TEST REQUIREMENTS, NPC 500-10. The Apollo Test Requirements (ATR), NPC 500-10, provides test policy, establishes minimum test requirements, and gives test documentation requirements which are to be met by all Centers. The ATR is applicable to all ground and flight tests of space vehicle hardware and associated active ground support equipment (GSE). Center Apollo Program Offices - R&QA will ensure that R&QA requirements are integrated into the test program as provided in the ATR.

2.3.11 APOLLO METROLOGY REQUIREMENTS MANUAL, NHB 5300.2. The Apollo Metrology Requirements Manual provides requirements and criteria for maintenance of uniform measurements of high accuracy throughout the Apollo program. Center Apollo Program Offices - R&QA will be responsible for assuring that the requirements of this manual are applied to all Centers, sites, and their contractors.

2.3.12 OTHER APOLLO R&QA DOCUMENTATION

a. When existing NASA or other Government Agency R&QA documents are found to be inadequate in fulfilling the R&QA needs of the Apollo Program, the Apollo Program Office - R&QA and/or Center Apollo R&QA personnel will develop additional standards, guidelines and directives. These will be developed to implement program requirements, and include such documents as: Manual for Evaluating Contractor Reliability Plans

and Performance, NHB 5320.2; Quality Program Evaluation Procedures, SP-6003; Apollo Reliability Estimation Guidelines, RA 006-007-1; and Delegation of Apollo Parts Information Activity Responsibility to MSFC, M-I MA 1450.045.

b. It is the responsibility of Center Apollo R&QA personnel to bring to the attention of the Apollo Program Office - R&QA any problem areas where inadequate documentation exists. The Apollo Program Office - R&QA will take necessary steps to implement preparation and issuance of appropriate directives, technical standards, guidelines, and similar documents in accordance with procedures of NPC 500-6.

2.4 R&QA PROGRAM IMPLEMENTATION

2.4.1 GENERAL

a. The implementation of the Apollo R&QA Program is based on the phased application of R&QA requirements, and the continuous evaluation of the degree of achievement of these requirements. Four organizational levels of the Apollo R&QA Program are defined for program implementation purposes:

(1) Level I Apollo Program Office

(2) Level II Center Apollo Program Offices

(3) Level III Contractors
Level IIIA Government Agencies

(4) Level IV Subcontractors and Suppliers

b. The responsible R&QA organizations at each of these levels will develop and implement R&QA programs to ensure the accomplishment of established program objectives by the line organizations. Four key implementation activities for these levels are outlined in paragraphs 2.4.2 and 2.4.3 below, and described in detail in Section 3, R&QA Plans; Section 4, Mission Reliability Analysis; Section 5, R&QA Status Reporting; and Section 6, R&QA Auditing.

2.4.2 LEVEL I - APOLLO PROGRAM OFFICE. The Apollo Program Office - R&QA will assure that appropriate R&QA policies and requirements are developed and implemented throughout the Apollo Program. To provide program visibility, periodic program and mission evaluations will be performed, based on organized and systematic analyses of elements of the program and selected missions. These analyses will be based on Center/contractor quantitative and qualitative inputs, both formal and informal. They are keyed to missions of current interest and presented to the Apollo Program Director as a status report with appropriate

conclusions and recommendations. The effectiveness of the R&QA Program will be assured through the following Apollo Program Office - R&QA activities:

a. Implementation of Apollo R&QA requirements through activities carried out under the provisions of this plan and related R&QA plans at lower levels.

b. Assessment of mission success and crew safety against assigned goals for selected hardware systems and missions of the Apollo Program through mission model analyses, to the level necessary to verify results.

c. Establishment of status reporting for evaluating progress in achieving Apollo program and mission R&QA objectives. The Apollo R&QA Program Quarterly Status Report to the Apollo Program Director includes both program and mission evaluations.

d. Performance of periodic surveillance and auditing of R&QA activities performed by the various participants of the Apollo program.

2.4.3 LEVEL II - CENTER APOLLO PROGRAM OFFICE. The Center Apollo Program Offices - R&QA will assure that appropriate R&QA requirements are developed and implemented by their Apollo contractors and Center line organizations. Center Apollo Program Offices - R&QA will implement the following activities as a basis for Center program and hardware evaluations:

a. Implementation of Apollo R&QA requirements through activities carried out under the provisions of Center R&QA plans and lower level contractor and Government Agency plans.

b. Assessment of hardware reliability and crew safety against goals apportioned to the hardware systems, through model analyses, to the level necessary to verify results.

c. Establishment of reporting systems for evaluating progress in achieving Center program and hardware R&QA objectives. Status reports will be keyed to Center management and Level I needs.

d. Performance of periodic surveillance and auditing of R&QA activities conducted by Center line organizations, contractors, and Government Agencies.

2.4.4 LEVEL III - CONTRACTOR. The Apollo contractors will implement the R&QA requirements established by the Center Apollo Program Offices - R&QA and will ensure that their subcontractors develop and implement R&QA programs in accordance with these requirements. The four activities detailed for Levels I and II will be carried out by contractors to the extent required by Centers.

2.4.5 LEVEL IIIA - GOVERNMENT AGENCY. The Government Agencies will implement the R&QA requirements established by the Center Apollo Program Offices - R&QA. Generally, these will include planning, inspection, reporting, and auditing activities.

2.4.6 LEVEL IV - SUBCONTRACTOR AND SUPPLIER. The Apollo subcontractors will implement the R&QA requirements established by the Apollo contractors. All four activities detailed for Levels I and II may be carried out by major subcontractors to the extent required by prime contractors.

2.5 APOLLO R&QA DATA SYSTEM

Apollo R&QA Offices are responsible for implementing a system to obtain information required for R&QA activities, which is generated within NASA, other Government Agencies, contractors, and subcontractors. These data systems will be capable of:

a. Providing systematic storage of R&QA information.

b. Providing data in a form capable of exchange among contractors and Centers to support interface requirements.

c. Providing historical records.

d. Providing a system adaptable to machine coding and operation.

e. Providing supporting data to meet the Apollo Program Office - R&QA and Center Apollo R&QA information requirements.

f. Supporting the Apollo parts program, Apollo Parts Information Center (APIC).

2.6 APOLLO FAILURE AND DEFECT REPORTING, ANALYSIS AND CONTROL

2.6.1 GENERAL. Apollo R&QA offices are responsible for assuring that Centers and contractors employ a controlled system for reporting, analyzing, correcting, verifying, and feeding back data on all failures and defects (discrepancies). See Appendix C for definitions.

2.6.2 PRE-LAUNCH

a. Failure and defect reporting will commence with engineering release to manufacturing of design drawings for flight hardware, launch complex, and related support equipment and will continue through all subsequent phases including flight operation.

b. Every defect observed or encountered during inspection of flight equipment (including pertinent GSE) will be recorded and reported in order to initiate corrective action (via MRB, as appropriate)

in quality control processes and procedures, and to establish quality trends.

c. Every failure encountered in testing, checkout, or operation of flight equipment (including GSE and GOSS interface equipment) will be verified, recorded, analyzed, compared with previous occurrences, and corrected on the item and subsequent items, so that no unexplained failures will be present in Apollo hardware. Human errors during testing and training will be recorded.

d. Reporting procedures will be established and implemented to ensure dissemination and control of failure and defect information (Example - UCR).

e. Failure and defect records will contain the following minimum information:

(1) Failure and Defect Report Requirements (only those items indicated with an asterisk (*) are required in defect reporting)

(*) • Report number and date
(*) • Reference to related failure defect reports
(*) • Reporting organization, individual and location
(*) • Date of failure/defect observance
(*) • Designation as to whether condition reported is a failure or defect
(*) • Affected item name, part number, serial number and manufacturer
• Next higher assembly name, part number, serial number and manufacturer
• Functional subsystem name
(*) • Stage/module name and serial number
(*) • Type of activity being conducted and reference procedure
(*) • Hardware phase
(*) • Environmental conditions
• Operating time or cycles
• Criticality of failure (consistent with NPC 500-10)
• Type of failure
  • Primary-design, quality, human induced, other
  • Secondary-induced by a primary failure
(*) • Description of defect/failure (include symptom observed, mode and probable cause in failure description)
• Remedial action taken
• Time to repair
(*) • Authorized NASA signature.

(2) Failure and Defect Analysis Report Requirements

(*) • Report number and date
(*) • Reference to original report number and related reports
(*) • Name of organization and principal investigator for the analysis

(2) Failure and Defect Analysis Report Requirements (Cont'd)

(*) • Determination of the cause
• Summary of previous occurrences
(*) • Recommended course of corrective action
(*) • Verification of appropriate information on the report
(*) • Authorized NASA signature validating both the analysis and recommended corrective action.

(3) Recurrence Control Report Requirements

(*) • Report number and date
(*) • Reference to the original report number and related reports
(*) • Corrective action statement
(*) • Effectivity date and hardware serial number
• Type and results of verification test
(*) • Authorized NASA signature.

f. Each Center Program Office will make provisions for a data bank system (computerized, where practicable) for storage and rapid retrieval of failure and defect information.

g. Each Center Program Office will prepare and disseminate periodic summaries on manufacturing and post-manufacturing defects, unresolved failures and corrective actions. The reports shall be designed and scheduled to provide information for management visibility at all levels, including monthly MSF Program Reviews reliability and quality status reports, as well as for requirements of key checkpoints in accordance with Apollo Program Directive No. 6, M-D MA 1400.006.

h. NASA Management Instruction 8020.3A, Manned Space Flight Flash Reports establishes formal requirements for MSF Program Managers to inform promptly the OMSF Program Director of any event, activity or condition that jeopardizes or has the potential of adversely affecting program objectives, schedules or cost. A copy of Flash Reports relating to equipment failures will be sent to the Apollo Program Office-Test, and the Apollo Program Office-R&QA.

i. NASA Management Instruction 5310.1, Reporting of Parts and Materials Application Problems, establishes procedures for the inter-installation reporting of quality and application problems, results of failure analyses, and follow-up actions involving parts and materials. Apollo problem items having significant application in other NASA equipment will be reported to other NASA installations in accordance with the procedures of this instruction.

2.6.3 POST FLIGHT

a. Apollo R&QA Offices of the Centers are responsible for taking the following actions in the event of a critical flight failure:

(1) The deficiency will be corrected prior to follow-on flights, or

(2) A deviation approval will be obtained from the Apollo Program Director, Code MA, with copies to the Apollo Program Office - Test, and Apollo Program Office - R&QA.

Written notification of the corrective action taken in (1) above will be sent to the same distribution as in (2) above.

b. Flight Anomalies Reporting (FLARE) System

The detailed flight and post-flight reporting requirements are identified in the Apollo Test Requirements Document, NPC 500-10, and in Apollo Program Directive No. 19, Apollo Flight Evaluation Requirements. The Apollo Program Office - R&QA has the responsibility for tracing the status of all flight anomalies and their impact on future missions through the systematic recording and reporting, by means of the FLARE System, of the following:

(1) Identified mission failures and anomalies;

(2) The status of all planned corrective actions;

(3) The effect of corrective action on future missions;

(4) The relationship of flight failures/anomalies to significant items reported in past Flight Readiness Reviews and other Program sources; and

(5) The correlation between flight failures/anomalies and previous failure mode, effects and criticality analyses; trends and other related reliability and quality analyses.

2.7 APOLLO SINGLE FAILURE POINTS

All NASA activities with cognizance over design and development of Apollo flight equipment, launch complex equipments, and related support equipment which have major impact on mission success and crew safety are responsible for establishing and implementing procedures for reporting and controlling single failure points.

a. For each mission a single failure point summary of items listed in descending order within each criticality (priority) category, together with appropriate corrective actions underway, will be prepared, updated and submited to the Apollo Program Director either separately or as part of the reliability and quality status reporting.

b. Single failure point summaries will be updated on a scheduled basis and will be included and reviewed as a part of the six checkpoints listed in Apollo Program Directive No. 6 (M-D MA 1400.006).

2.8 APOLLO TEST

Apollo R&QA Offices are responsible for assuring the development of a failure mode, effects, and criticality analysis system for each stage, module and mission essential GSE, to determine criticality categories for tests, in accordance with the requirements of Tables 3-1 and 3-2 of the Apollo Test Requirements, NPC 500-10.

2.9 FLIGHT READINESS REVIEW (FRR)

2.9.1 RELIABILITY ASSESSMENT CONSIDERATIONS. The purpose of the FRR (Apollo Program Directive No. 8, M-D MA 2210.008) is to determine the readiness status of the spacecraft, launch vehicle, and launch complex in order to certify the flight readiness of the systems for the mission. The Apollo Program Office-R&QA is responsible for preparation and presentation of the reliability assessment portion of the review. The FRR reliability assessment will consider the following elements:

a. Failure mode, effect and criticality analyses.

b. Single failure points.

c. Mission level analysis to determine major "high risk" equipment contributors to mission risk.

d. Review of failure history and corrective action.

e. Waivers and deviations to contract end item specifications.

f. Status of reliability testing.

g. Status of critical life components and life remaining.

h. Overall test evaluation from reliability standpoint.

i. Review of pertinent R&QA program information.

2.9.2 RELIABILITY ASSESSMENT RECOMMENDATIONS. Based on consideration of the above elements, the FRR reliability assessment will provide the following:

a. Comparison of reliability assessment with assigned goals.

b. Qualitative assessment of critical mission hardware.

c. Identification of end items with low reliability.

d. Final conclusions and recommendations concerning flight readiness from the standpoint of reliability evaluation.

Section 3: RELIABILITY AND QUALITY ASSURANCE PLANS

3.1 GENERAL

Requirements and procedures for implementation of the Apollo R&QA Program will be developed in plans prepared by Center Apollo Program Offices - R&QA, Government Agencies, and contractors in accordance with requirements developed herein. The relationship of R&QA plans to program documentation and approval and/or review requirements is presented in Figure 3-1. This document (NHB 5300.1A) constitutes the Level I Plan.

3.2 LEVEL II - CENTER RELIABILITY AND QUALITY ASSURANCE PLANS

Each Center Apollo Program Office - R&QA is responsible for the development of Apollo R&QA plans based on the policies and requirements stated herein. Upon formal review by the Apollo Program Office - R&QA, these plans will serve as the operational plans for implementation of R&QA policies and requirements by the Center Apollo Program Offices. Center Apollo R&QA plans will include but not be limited to the following:

a. Internal organizational structure, functional responsibilities, interrelationships, methods of operation, management of hardware R&QA efforts and level of authority, at the Center, Center component, and/or Resident Offices. The Center Apollo R&QA organizational structure will be detailed in a manner similar to that for the Apollo Program Office - R&QA in M-D MA 500.

b. Plans for furnishing status of NASA-DoD R&QA support manpower.

c. Control procedures to assure that major procurement documents have been reviewed for adequacy of R&QA requirements, and approved.

d. Designation of Government Agencies and assignment of R&QA functions to Government Agency representatives at contractors' plants.

e. Procedures for judging adequacy of contractor and Government Agency R&QA plans and procedures, and time phasing for review and approval.

f. Plans for auditing R&QA activities at contractors and Government Agencies on a scheduled basis.

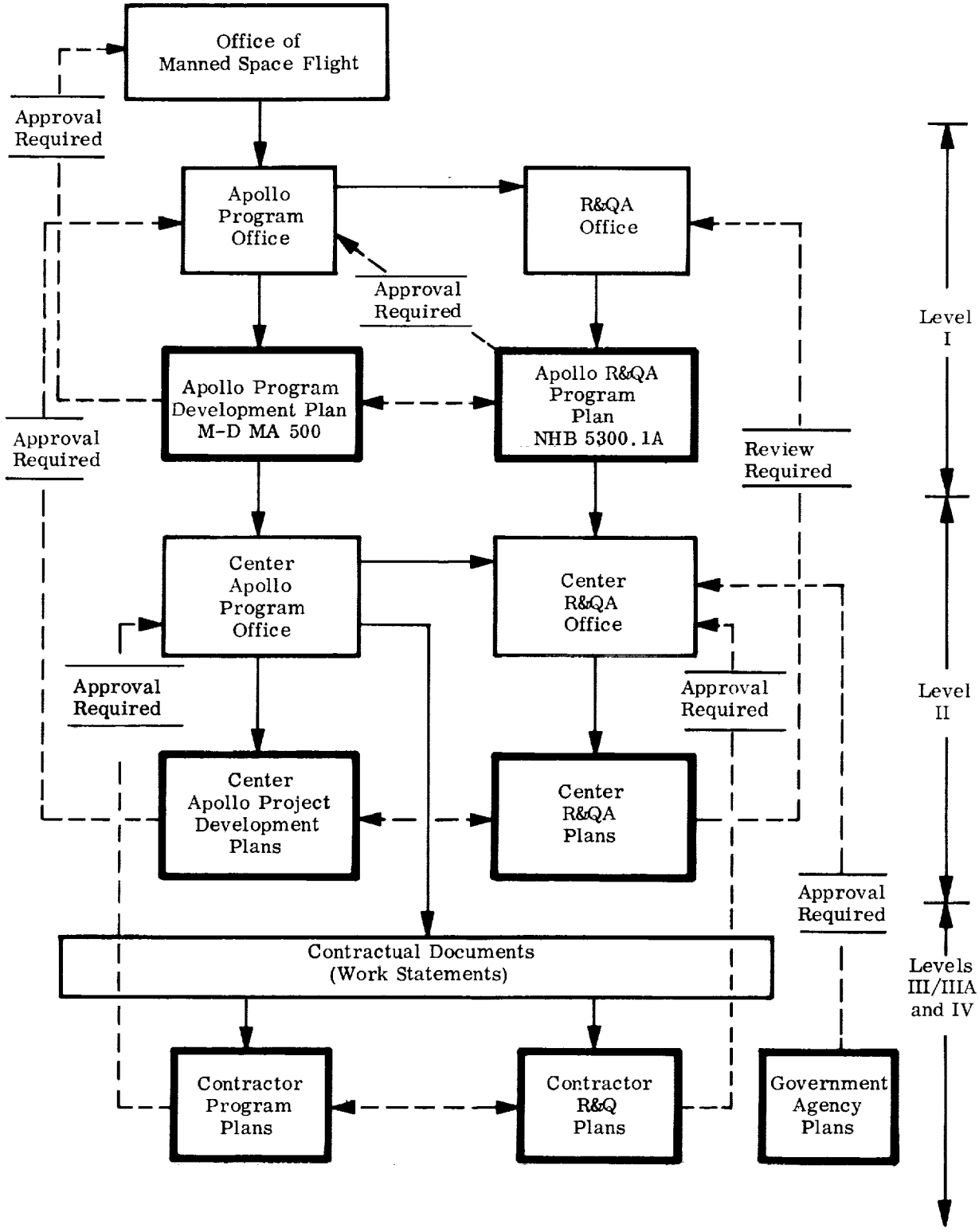


FIGURE 3-1. RELATIONSHIP OF PLANS AND APPROVAL REQUIREMENTS

g. Plans for developing reliability and quality assessments and status reports in response to requirements in this document (Ref. paragraph 5.3).

h. Plans for placing acceptance requirements in contractual documents and specifications, or revisions thereof.

i. Procedures for R&QA review of test plans to ensure integration of R&QA requirements, for R&QA monitoring of test performance and for R&QA evaluation of test results against acceptance requirements in specifications, including time phasing thereof.

j. Procedures for developing technical standards and guidelines.

k. Procedures for ascertaining the need for, and performance of R&QA training, including time phasing thereof.

l. Procedures for information collection and dissemination, including a description of the data system, and procedures for failure reporting and corrective action (Ref. paragraphs 2.5 and 2.6).

m. Procedures for conducting R&QA activities (e.g., inspection, system tests, calibration, etc.) both in-house and at other NASA locations under Center Apollo Program Office cognizance.

n. Schedules for accomplishing the activities listed.

Some of the above activities may be accomplished by organizational elements other than Center Apollo Program Offices - R&QA. In such cases, Center Apollo R&QA plans should state where these activities are carried out and by whom they will be accomplished.

3.3 LEVEL IIIA - GOVERNMENT AGENCY QUALITY ASSURANCE, INSPECTION AND/OR RELIABILITY ASSURANCE PLANS

Government Agency (GA) organizations, assigned quality assurance, inspection and/or reliability assurance functions by the Center Apollo Program Offices - R&QA, will prepare plans and procedures for implementing these functions at the contractors' plants. These GA plans will be prepared in accordance with the policies, requirements, and guidelines provided by the Center Apollo Program Offices - R&QA, and those of NPC 200-1A, Quality Assurance Provisions for Government Agencies. In cases where Government Agencies are assigned reliability assurance functions, they will key their activities to the provisions of NPC 250-1. When these plans are approved by the cognizant Center Apollo Program Office - R&QA, or its designee, they will serve as the basis for performance of the assigned functions.

3.4 LEVEL III/IV - CONTRACTOR RELIABILITY, QUALITY AND INSPECTION PLANS

a. Apollo contractors (and subcontractors, as appropriate) will prepare reliability, quality and/or inspection plans in accordance with the specific requirements detailed in the contractual work statement by Center Apollo Program Offices or their designees. These plans and

procedures will conform to the policies, requirements, and guidelines provided by the Center Apollo Program Offices - R&QA, Government Agencies and the applicable provisions of NPC 250-1, Reliability Program Provisions for Space System Contractors, NPC 200-2, Quality Program Provisions for Space System Contractors, or NPC 200-3, Inspection System Provisions for Suppliers of Space Materials, Parts, Components, and Services. For new procurement actions, a statement of work will normally require the contractor to submit a preliminary reliability, quality or inspection plan for eventual incorporation into the resulting contract. Although NPC 200-2 and NPC 200-3 do not require NASA Center approval of contractor quality or inspection plans, this approval requirement is mandatory for the Apollo program and must be placed into current operating procedures as expeditiously as possible.

b. Within the provisions established by NASA PR 400, reliability, quality and/or inspection plans, and any changes thereto, prepared by the contractors (and subcontractors as appropriate) will reflect the requirements imposed and will be consistent with the needs of the situation (e.g., equipment, complexity, criticality in the system, end use, maturity, etc.). When contractor reliability, quality and/or inspection plans are approved by the cognizant Center R&QA Office, they will serve as the basis for implementation of reliability, quality and/or inspection requirements throughout the contractors' activities. Procedures for implementation and changes thereto will be prepared by contractors (and subcontractors, as appropriate) and made available to the Center Apollo Program Office - R&QA or its designee for review or approval, as indicated in NPC 250-1, NPC 200-2, NPC 200-3, or the contract.

Section 4: MISSION RELIABILITY ANALYSIS

4.1 GENERAL

Apollo reliability analyses and modeling activities together constitute the overall mission reliability analysis. The latest reliability data will continually be assimilated and correlated with previous analyses to evaluate current status and progress toward goal achievement. The mission reliability analyses are based on a combination of the following activities at all levels of the program:

a. Detailed reliability analyses, based on such reliability engineering activities as, failure mode, effects, and criticality analysis (FMECA), single failure point analysis, analysis of test and operations plans and results, failure correction, adequacy of specifications, design reviews, etc., will be conducted. During the above analyses, modeling activity, at the appropriate level, will be used as a tool to assist in conducting analyses which involve interactions and interfaces between various mission and hardware aspects of the program.

b. Compatible reliability analysis models will be structured to provide a logical representation of mission and hardware aspects of the program. There will normally be some overlap in the level of detail considered at adjacent activity levels. Details on performing reliability analyses using mathematical models are given in Apollo Reliability Estimation Guidelines, RA 006-007-1.

4.2 LEVEL I - MISSION RELIABILITY ANALYSIS

a. The Level I mission reliability analysis is concerned with the total program aspects of mission reliability, including mission success, crew safety, and launch availability. This analysis considers the interfaces between the spacecraft, launch vehicle, launch complex and GOSS; the interactions between pre-launch and post-launch phases of the mission; and all mission and abort modes. The mission level model provides a means for evaluating the effect on mission reliability of program changes involving more than one Center, and it considers the interactions which affect mission plans, performance of systems, sequencing of events, and overall configuration. Two outputs of this analysis are:

(1) Mission Reliability Analysis Report, RA 007-001-1, and

(2) Apollo Systems Verification Report, RA 001-002 through 006-1.

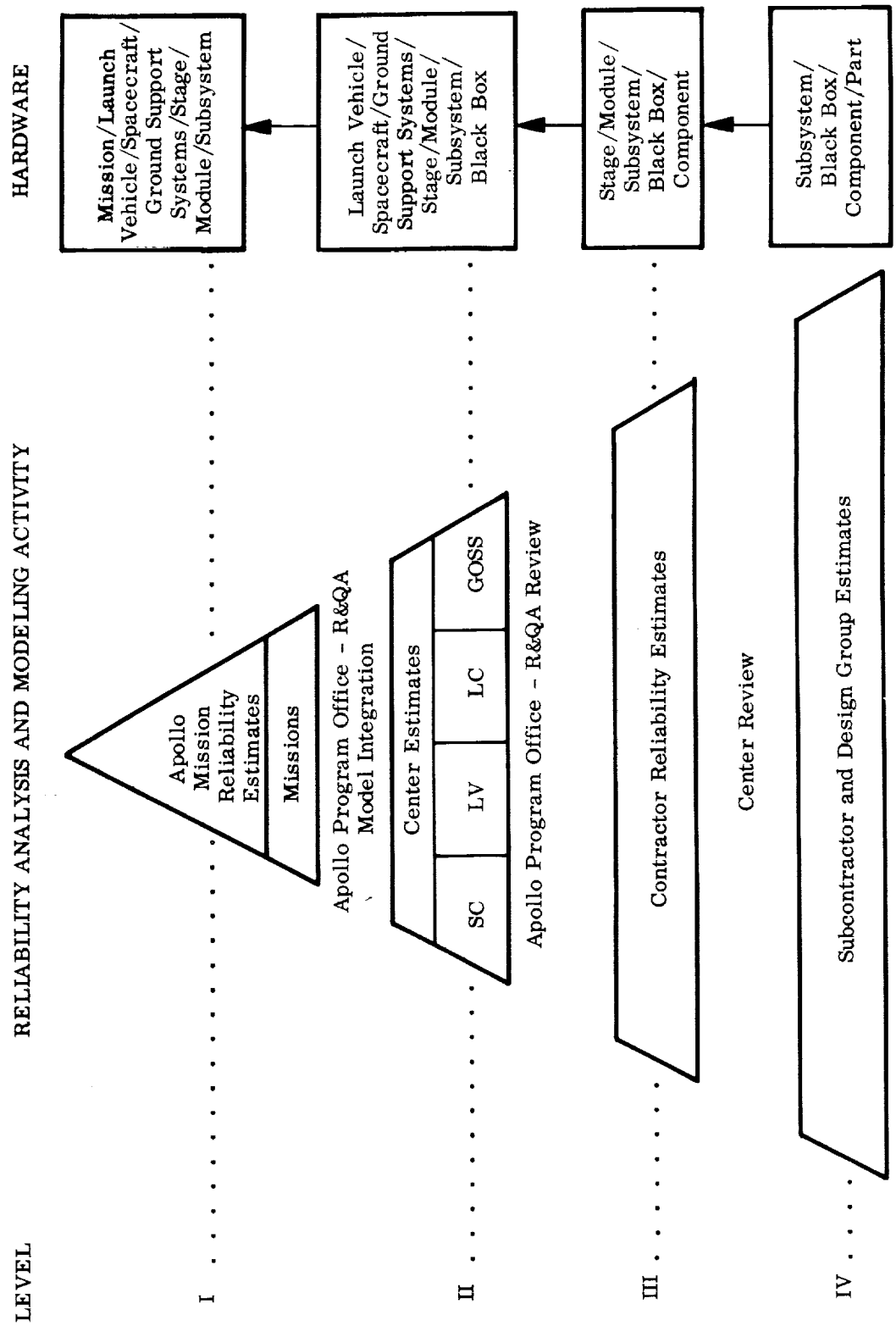


FIGURE 4-1. MISSION RELIABILITY ANALYSIS

b. The following information from the mission reliability analysis and system verification reports will be utilized as inputs to the mission evaluations for the Flight Readiness Reviews, the Design Certification Reviews, and the Apollo R&QA Program Quarterly Status Report.

(1) The status of reliability apportionments, predictions, and assessments as they relate to estimates of mission success probability, crew safety probability, and launch availability.

(2) A summary of major hardware and operational problem areas identified by discrepancies in apportioned versus estimated values of system reliabilities.

(3) An analysis of Apollo manned missions to determine the prior verification status of systems by planned and completed previous flight and ground testing and engineering assessment.

(4) A summary of major differences between currently achieved reliability and that expected for the particular stage of hardware maturity, obtained by compilation and analysis of hardware test results.

(5) An analysis of the overall risks associated with mission success probability, crew safety probability and launch availability, together with the impact of proposed major changes in the mission rules, the system hardware, and the mission operational procedures.

(6) A review of single failure points and their relative standing.

4.3 LEVEL II - CENTER RELIABILITY ANALYSIS

Center reliability analysis and modeling activity will consider subsystems, stage, module, and if necessary, specific equipments; and will be conducted for the spacecraft, launch vehicle, launch complex, and GOSS. Reliability analysis includes reliability engineering activities previously described. Center modeling activity will emphasize the interfaces between various contractors. Center reliability analyses will be updated in those areas which contribute most to unreliability. Center Apollo R&QA personnel will use the support of Center design engineers in analyzing modeling inputs to verify input validity.

4.4 LEVEL III - CONTRACTOR RELIABILITY ANALYSIS

Apollo contractors will conduct reliability analysis and modeling activities for specific equipment and component parts in accordance with Center requirements. Specifically, these analyses and models will reflect the level of part detail necessary to establish meaningful equipment estimates.

4.5 LEVEL IV - SUBCONTRACTOR RELIABILITY ANALYSIS

Major subcontractors, and others as required, will conduct reliability analyses and modeling activities for their specific equipment and component parts, in accordance with the requirements established for the prime contractor models. Similarly, these analyses and models will reflect the level of part detail necessary to establish meaningful equipment estimates.

4.6 CENTER/APOLLO PROGRAM OFFICE - R&QA REVIEW

a. A Center/Apollo Program Office - R&QA review will be conducted at all levels to ensure the compatibility of inputs to the next higher level model. Each Center will review and monitor the inputs to each contractor's model to ensure that the outputs of the resulting model are suitable for combination into the Center's model. At the next echelon, an Apollo Program Office - R&QA technical team will review and monitor, with the Centers, the inputs to the Center's model to ensure that the outputs of the resulting model are suitable for use in the mission model.

b. Although there is nominally only one level of overlap necessary in the formal modeling information, each echelon of modeling will have the authority to "test the system" (i.e., to examine selected portions of the model in greater detail than normal) in order to attain an understanding of the modeling procedures and to act as a check and balance to maintain the integrity of overall results. For example, this will, on some occasions, involve and examination of a "thin slice" of the model at a subcontractor's plant by a joint team of Apollo Program Office - R&QA, Center and prime contractor reliability and design engineers.

4.7 DATA REQUIREMENTS

a. The following data, at a level of detail appropriate to the level of analysis concerned, are required:

(1) Mission profile.

(2) Mission operational ground rules

(3) System and program element functional logic/block diagrams and supporting rationale.

(4) Reliability models including reliability logic diagrams.

(5) Apportionment logic and estimates.

(6) Failure mode and effects analyses.

(7) Criticality rankings.

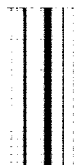
(8) Failure rate (or other failure distribution parameters) information, and supporting rationale.

(9) Qualitative assessments of the validity of assumptions and data inputs.

(10) Quantitative assessments based on most recent test data.

f. The data must necessarily flow upward to the next level to meet the data input needs of the level above. There will be additional requirements for certain data items, such as (1) and (2) above, to flow downward for uniformity between the lower level models. The hardware analyses will generally flow upward to the next level of modeling as follows:

Level II to Level I	Launch vehicle/spacecraft/ground support systems/stage/module/subsystem/black box
Level III to Level II	Stage/module/subsystem/black box/component
Level IV to Level III	Subsystem/black box/component/part



Section 5: RELIABILITY AND QUALITY ASSURANCE STATUS REPORTING

5.1 GENERAL

5.1.1 INFORMATION CATEGORIES. R&QA status reporting for the Apollo Program will be implemented in accordance with the requirements established herein. The primary objective of R&QA status reporting is to provide NASA management with status and progress information in three major categories:

a. Information of a technical nature for reliability and quality evaluation (apportionment, prediction, assessment, malfunctions, defects, test results, etc.).

b. Information related to management and administrative aspects (plans, status reports, schedules, funding, manpower, etc.), and

c. Recommendations for the solutions of problems requiring management action.

5.1.2 REPORTING LEVELS. R&QA status reporting will be implemented at the following levels:

a.	Level I	The Apollo Program Office - R&QA to the Apollo Program Director
b.	Level II	Center Apollo Program Offices - R&QA to the Apollo Program Office - R&QA and Center Director and Program Manager, as appropriate.
c.	Level III	Contractors and Government Agencies to Center Apollo Program Offices - R&QA (This will include Center line organizations to Center Apollo Program Offices - R&QA, as applicable.)
d.	Level IV	Subcontractors/Suppliers to Contractors

5.1.3 REPORTING DETAIL. The status reports will be prepared at each level, to reflect the analysis of the program performed at that level. The amount of detail in reports submitted to the next higher level will be compatible with the decision making authority of that level. It is the responsibility of R&QA organizations at all levels to generate their own report requirements. They will coordinate these requirements with other organizational elements having related reporting requirements to ensure integrated effort and unified direction, and provide information to organizational levels above and

below the representative level as required to fulfill the needs of the program. The reports will be submitted to the next higher level in accordance with schedules required by the next higher level.

5.2 LEVEL I - APOLLO R&QA PROGRAM QUARTERLY STATUS REPORT

5.2.1 GENERAL. An Apollo R&QA Program Quarterly Status Report will be prepared by the Apollo Program Office - R&QA, and presented to the Apollo Program Director every three months starting July 1965. This report will be based on an analysis and evaluation of Center/contractor status reports and inputs directed to three major areas:

a. Mission Evaluation

b. R&QA Program Evaluation

c. Problems and Recommendations

Figure 5-1 illustrates the approach used in developing these three major areas of the report. The paragraphs that follow, describe these reporting areas in some detail. The Apollo R&QA Program Quarterly Status Report will be reviewed and coordinated with Centers and other directorates of the Apollo Program Office prior to presentation to the Apollo Program Director. It will be furnished officially to Centers every three months for information and action, as appropriate.

5.2.2 MISSION EVALUATION. Specific mission evaluations will be made to define the relationship between the results of mission reliability analyses and the established mission requirements, and will be keyed to the capability of the total Apollo system (equipment and facilities) to meet the launch window for a particular mission. This would require analysis and trade-offs among such factors as reliability, maintainability, and launch time availability. The following results will be presented as part of the Apollo R&QA Program Quarterly Status Report.

a. The status of missions of current interest based on the outputs of the mission reliability analysis, as defined in paragraph 4.2 above.

b. The projected impact on the Manned Lunar Landing (MLL) mission, of any problems encountered in the missions of current interest.

c. The status of the Manned Lunar Landing mission, based on the outputs of the mission reliability analysis, as defined in paragraph 4.2 above.

Emphasis will be placed on the identification of critical areas requiring management action.

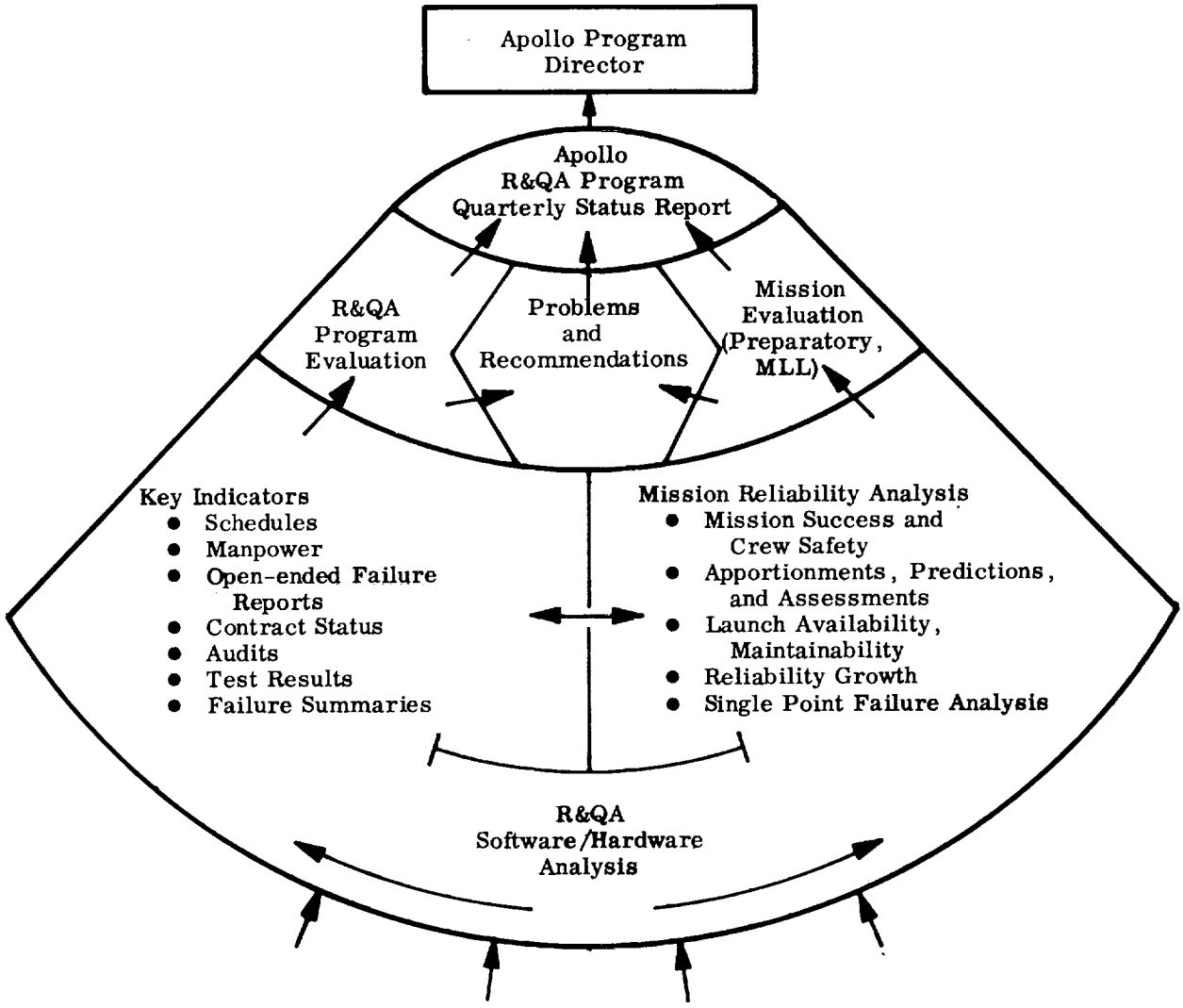


Figure 5-1. Apollo Program R&QA Status Report

5.2.3 R&QA PROGRAM EVALUATION. The R&QA Program evaluations will define the current status of program implementation related to the overall program requirements established in Section 2 of this Plan. Key indicators, such as: schedules, manpower, contract status, audits, test results, failure summaries including specific open-ended trouble/malfunction/failure reports, and problems identified as a result of mission reliability analyses will be evaluated in the program context to provide a basis for recommendations to the Apollo Program Director. The results will be presented as part of the Apollo R&QA Program Quarterly Status Report.

5.2.4 PROBLEMS AND RECOMMENDATIONS. The problems defined by the mission and program evaluations will be summarized and evaluated. Those requiring management action will be identified and specific recommendations will be made regarding solutions to these problems.

5.3 LEVEL II - CENTER R&QA STATUS REPORTING

5.3.1 GENERAL. The Center Apollo Program Offices - R&QA are required to submit R&QA status information to fulfill the Level I needs. The status reporting will be accomplished as described in the Center R&QA plans and will involve both formal and informal submissions in accordance with the Apollo Program Office - R&QA requests and schedules. In general, Center R&QA status information will be submitted to the Apollo Program Office - R&QA four weeks prior to the presentation of the Apollo R&QA Program Quarterly Status Report to the Apollo Program Director. This status information will include Center Apollo R&QA reports to Center management, and the following information for the Apollo R&QA Program Quarterly Status Report:

a. Center reliability analysis models and supporting data for the mission model.

b. An evaluation of each Center's portion of the total Apollo R&QA Program.

c. Specific problems and recommendations.

5.3.2 CENTER APOLLO R&QA HIGHLIGHTS. Weekly highlight reports for the spacecraft, launch vehicle, launch and flight operations, and engines are submitted to the Apollo Program Office by the Center Apollo Program Offices, in accordance with the Apollo Documentation Index, NPC 500-7. R&QA problem areas will be included in these reports.

5.4 LEVEL III - CONTRACTOR AND GOVERNMENT AGENCY R&QA STATUS REPORTING

R&QA status reporting at this level will be in accordance with the requirements and schedules established by the Center Apollo Program Offices, and the contract.

5.5 LEVEL IV - SUBCONTRACTOR/SUPPLIER R&QA STATUS REPORTING

R&QA status reporting at this level will be in accordance with the requirements and schedules established by the prime contractors.

Section 6: RELIABILITY AND QUALITY ASSURANCE AUDITING

6.1 GENERAL

This section defines the requirements for establishing and implementing an Apollo R&QA Audit Program in accordance with the provisions of this plan and the Apollo Program Development Plan, M-D MA 500. It covers the following requirements:

a. Periodic scheduling of audits to assess the implementation of Apollo reliability and/or quality assurance requirements.

b. Definition of organizations responsible for auditing.

c. Procedures for performing audits.

d. Procedures for reporting results of audits and prescribed corrective actions.

e. Procedures for follow-up of prescribed corrective actions to assess the degree of accomplishment.

6.2 AUDITING ORGANIZATIONS

The responsible R&QA organizations at the four levels of the Apollo R&QA Program will perform R&QA audits as follows:

6.2.1 LEVEL I - APOLLO PROGRAM OFFICE. The Apollo Program Office - R&QA is responsible for auditing performance of Apollo R&QA Offices at the Manned Space Flight Centers.

6.2.2 LEVEL II - CENTER APOLLO PROGRAM OFFICES. The Center Apollo Program Office - R&QA (or delegated Center R&QA organizations) is responsible for auditing:

a. The performance of Center line organizations assigned Apollo R&QA responsibilities.

b. The activities of the Government Agencies (including NASA resident R&QA personnel) assigned to Apollo contractors' and suppliers' plants.

c. The activities of Apollo contractors, subcontractors, and suppliers under their cognizance.

6.2.3 LEVEL IIIA - GOVERNMENT AGENCIES. The Government Agencies (including NASA resident R&QA personnel) assigned at contractors', subcontractors', and suppliers' plants are responsible for auditing the Apollo R&QA activities performed by the contractor, subcontractor, or supplier as directed by the Center letter of delegation.

6.2.4 LEVEL III/IV - CONTRACTORS/SUBCONSTRACTORS. The Apollo contractors/subcontractors are responsible for auditing:

a. The performance of their own in-house R&QA activities, as required by contract.

b. The performance of their subcontractors and suppliers, as required by contract.

Figure 6-1 provides a summary chart of the Apollo R&QA audit activities.

6.3 AUDIT GUIDELINE PROCEDURES

6.3.1 GENERAL. Each organization performing audits will follow the general guideline procedures listed below, as well as the specific procedures in ensuing paragraphs.

a. Schedules of audits planned during the next quarter will be maintained and the next level above and the organization to be audited will be notified officially at least one month in advance of each audit.

b. Each official audit will be made by a team selected by the auditing agency with an individual designated as chairman.

c. Audits of R&QA activities may be performed separately or jointly, as desired. Audits will be conducted in general accordance with the Manual for Evaluating Apollo Contractor Reliability Plans and Performance, NHB 5320.2, and/or Quality Program Evaluation Procedures, SP 6003, except that numerical ratings are not mandatory.

d. Immediately following the audit, a post audit critique will be held between the audit team and appropriate personnel of the organization being audited to discuss the findings of the audit. The organization audited will thus be made aware of the findings and be given an opportunity to defend them prior to issuance of a formal report.

LEVEL	ACTIVITY PERFORMING AUDIT	ACTIVITY BEING AUDITED	FORMAL AUDIT REPORT DISTRIBUTION[1]
I	Apollo Program Office - R&QA (Code MAR)	CPO	CPM
II	Center Apollo Program Office - R&QA CPO[2]	Center Line Organization	CPM, CD, Code MAR (via CD) CTR[3]
II	CPO[2]	GA	SGA, CPM, CTR[3], Code MAR
II	CPO[2]	Contractor/Subcontractor/Supplier	CPM, GA, CTR[3], Code MAR
IIIA	Government Agency Assigned at Contractors' Plants (GA)	Contractor/Subcontractor/Supplier	CPM, CPO, CTR[3], Code MAR
III/IV	Contractor/Subcontractor	Contractor/Subcontractor (themselves)	GA, Contr[3], CPO[3]
III/IV	Contractor/Subcontractor	Subcontractor/Supplier	GA, Contr[3], CPO[3]

Code MAR: Apollo Program Office - R&QA
CPO: Center Apollo Program Office - R&QA
CPM: Center Apollo Program Manager
CTR: Center In-House R&QA Office
GA: Supervisory Office of GA
CD: Center Director

[1] In addition to organizations auditing and being audited
[2] or delegated representative
[3] if appropriate

FIGURE 6-1. APOLLO R&QA AUDIT SUMMARY

e. At the completion of each audit, the audit chairman, or his designee, will prepare and issue a formal report of the results of the audit, structured as given in paragraph 6.4 below, and will include in the report specific recommendations for corrective action by specified organization groups.

f. After the audit report has been distributed, the auditing agency will follow up to assure that action items and recommendations for corrective action have been implemented.

6.3.2 LEVEL I - THE APOLLO PROGRAM OFFICE - R&QA AUDITS OF CENTER APOLLO PROGRAM OFFICES - R&QA

a. The Apollo Program Office - R&QA audits the activities and performance of the Center Apollo Program Offices - R&QA at intervals, as required, to ensure the execution and implementation of the Apollo Program R&QA policies, procedures, and requirements.

b. For any planned formal audits, notification of Center Apollo Program Offices - R&QA will include the following:

(1) Scope of audit; i.e., KSC R&QA Program, Saturn IB R&QA Program, etc.

(2) Inclusive dates of audit, including time of arrival.

(3) The Apollo Program Office - R&QA Chairman and delegated members of the auditing group. The audit team will be comprised of Apollo Program Office - R&QA and Center personnel.

(4) Advance preparations (if any) to be made by the Center; i.e., assembling appropriate records, etc.

c. The purpose of a formal audit is to determine the degree and adequacy of compliance with the Centers' Apollo R&QA Program Plans. Also, the establishment and implementation of intra-Center Apollo R&QA policy and operating procedures by the Center Apollo Program Office - R&QA will be observed. In addition, the Apollo Program Office - R&QA will participate in Center R&QA audits of Government Agencies/contractors/subcontractors/suppliers. This participation will be coordinated with the appropriate Center Apollo Program Office - R&QA.

d. As a minimum, copies of the audit report will be furnished to the Apollo Program Office - R&QA and the Center Apollo Program Office - R&QA and the Center Apollo Program Manager.

6.3.3 LEVEL II - CENTER APOLLO PROGRAM OFFICE - R&QA AUDITS OF THE R&QA ACTIVITIES PERFORMED BY CENTER LINE ORGANIZATIONS

a. The Center Apollo Program Office - R&QA (or delegated Center organization) will perform audits of the performance of the R&QA activities of Center line organizations at intervals, as required to ensure the execution and implementation of the applicable Apollo Program R&QA policies, procedures, and requirements.

b. The purpose of these audits is to evaluate the degree and adequacy of compliance of the line organizations in each of the following Apollo R&QA activities:

(1) Compliance with the requirements of the Center Apollo R&QA plan.

(2) Compliance with the requirements of Center R&QA operating policy, plans, and procedures.

(3) Compliance with the requirements of Apollo R&QA reporting procedures.

(4) The status of plans for and usage of manpower in the accomplishment of the line organization's R&QA activities.

(5) Compliance with the requirements for the management of Government R&QA functions at supplier operations.

(6) Compliance with the requirements for the review and contribution to contract requirements; and the assessment and management of contractor R&QA functions and activities.

(7) Compliance with the requirements for implementation of Apollo R&QA technical standards and guidelines.

c. Copies of the report will be furnished to each of the line activities audited, appropriate Center Director, Center Apollo Program Manager, Apollo Program Office - R&QA via the Center Director, and will be kept in a central audit file maintained by the cognizant Center R&QA Activity.

6.3.4 LEVEL II - CENTER APOLLO PROGRAM OFFICE - R&QA AUDITS OF THE R&QA ACTIVITIES PERFORMED BY GOVERNMENT AGENCIES AT CONTRACTORS', SUBCONTRACTORS', AND SUPPLIERS' PLANTS

a. The Center Apollo Program Office - R&QA (or delegated Center organization) will audit the Apollo R&QA activities of the Government Agencies (including NASA resident R&QA personnel) at contractors', subcontractors', and suppliers' plants, as required, to evaluate the effectiveness of the Agency's R&QA performance.

b. The purpose of these audits is to evaluate the degree and adequacy of compliance of the Government Agency with each of the following:

(1) The provisions of NPC 200-1A.

(2) The provisions of the Government Agencies' R&QA plans.

(3) The status of the Government Agencies' Apollo Program activities as reported in their periodic R&QA activity reports.

c. Copies of the audit report will be given to each of the Government Agencies audited, the appropriate supervising office of the Government Agency audited, the Center Apollo Program Manager, the Apollo Program Office - R&QA, and will be kept in a central audit file by the cognizant Center R&QA Activity.

6.3.5 LEVEL II - CENTER APOLLO PROGRAM OFFICE - R&QA AUDITS OF THE R&QA ACTIVITIES OF APOLLO PROGRAM CONTRACTORS, SUBCONTRACTORS, AND SUPPLIERS

a. The Center Apollo Program Office - R&QA (or delegated Center organizations) will audit the activities and performance of the Apollo Program contractors, subcontractors, and suppliers, as required, to evaluate adequacy and degree of compliance with the appropriate contractual R&QA requirements.

b. Copies of the audit report will be distributed to Center Apollo Program Managers, appropriate Government Agencies, the Apollo Program Office - R&QA, and will be kept in a central audit file by the cognizant Center R&QA Activity.

c. On the first of October 1965 and every three months thereafter, the Center Apollo Program Office - R&QA will issue a proposed schedule of contractor audits to be performed during the next three months. This schedule will be sent to the Apollo Program Office - R&QA where the list will be compared with those issued by other Centers. If it should become apparent that two or more audits are planned to be made upon the same contractor during the reporting period (by different auditing activities), the Apollo Program Office - R&QA will attempt to combine audit plans so that a minimum interference of contractor activities will result.

6.3.6 LEVEL IIIA - GOVERNMENT AGENCY AUDITS OF CONTRACTORS' R&QA ACTIVITIES

a. The Government Agency (including NASA Resident R&QA personnel) assigned to contractors' plants will perform audits of the R&QA activities performed by Apollo contractors under their cognizance, as indicated in the letter of delegation. Proposed

schedules of these audits will be forwarded to the cognizant Centers, as required by the Center.

b. These audits will be performed in accordance with the requirements of NPC 200-1A, Section 4, Surveying and Monitoring, as amplified by the documents referred to in paragraph 6.3.1 (c) above. These audits may be combined with Center-originated audits or as a supplement to Center audits.

c. Copies of the audit report will be sent to the Center Apollo Program Manager, the Center Apollo Program Office - R&QA, the Apollo Program Office - R&QA, and the cognizant center Activity.

6.3.7 LEVEL III/IV - CONTRACTORS'/SUBCONTRACTORS' AUDITS OF THEIR OWN R&QA ACTIVITIES

a. When contractually required, Apollo contractors/subcontractors will audit their own quality activities on a timely basis in accordance with the requirements of NPC 200-2, Section 15, Audit of Quality Program Performance.

b. When contractually required, reliability program audits will be performed periodically as outlined in paragraph 2.3 of NPC 250-1. Control and audit of a contractor's reliability program will be conducted as outlined in paragraph 2.4 of NPC 250-1. These audits will include and emphasize the Reliability Evaluation Program and adhere to the suggested procedures of paragraph 4.5 of NPC 250-1.

c. Audit reports will be submitted to the cognizant contracting NASA Center, Government Agency (including NASA R&QA representatives) and prime contractor, as appropriate.

6.3.8 LEVEL III/IV - CONTRACTORS'/SUBCONTRACTORS' AUDITS OF SUBCONTRACTOR AND SUPPLIER R&QA ACTIVITIES

a. When contractually required, contractors/subcontractors will audit the activities and performance of major subcontractors/suppliers in a manner similar to that described in paragraph 6.3.5 above.

b. In each case, auditing contractor/subcontractor will present to the cognizant Center/prime contractor a listing of audits to be performed at least a month prior to the actual performance of the audit. The Center R&QA Office will review the schedule and participate in the audits, as appropriate.

c. Audit reports will be submitted to the cognizant NASA Center, Government Agency (including NASA resident R&QA personnel), and prime contractor, as appropriate.

6.4 AUDIT REPORTS

A formal written report is the end product of the combined efforts of the R&QA Audit Team. The final audit report will include the following information when feasible:*

Section 1: INTRODUCTION

1.1 Purpose, which should explain the reasons for conducting the audit.

1.2 Scope, which should describe the scope of the audit, including any limitations that may have been imposed.

1.3 Survey Team, which should list the team membership and designate their titles and organizational affiliations.

1.4 Itinerary, which should describe the organization(s) audited, physical location(s), and the dates of the audits.

Section 2: AUDIT RESULTS AND RECOMMENDATIONS

2.1 Audit Summary, which should summarize the results of the audit in a brief abstract of the major audit findings.

2.2 Recommendations, which should detail all of the recommendations made as a result of the audit. Each specific recommendation should designate the organization responsible for action in its accomplishment.

Section 3: DETAILED AUDIT DESCRIPTION

a. Subject of the audit.

b. Description of the findings including a description of the problem, cause of the problem, effect of the problem, and an indication of a specific need for corrective action.

c. Discussion of the pertinent facts examined or revealed during the audit.

d. Recommendations for action as a result of each specific problem discussed, showing which organizations are responsible for action, and when follow-up action should or will be performed.

Section 4: APPENDIX, which will give supplementary data, such as charts, description of the activity or hardware, pertinent documentation, etc.

*It is not anticipated that all reports will include all of the details listed herein. The reports will vary owing to complexity of item, extent of audit, etc.

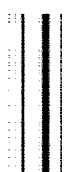
6.5 FOLLOW-UP ACTIONS

6.5.1 GENERAL. The most important part of an audit program is the benefit that accrues to the entire Apollo Program by the accomplishment of the prescribed corrective action. In order to ensure that the corrective action has been accomplished, or that subsequent facts have indicated that some other action should be followed, a specific follow-up system will be employed by all activities having an audit function.

6.5.2 INFORMAL FOLLOW-UP ACTION. The initial follow-up action will be performed through the use of a phone call, memorandum, or letter to the activity responsible for implementation of corrective action. The interval after the audit and before implemental follow-up action will vary with the complexity and importance of the corrective action, but will not normally exceed 30 days.

6.5.3 FORMAL FOLLOW-UP ACTION. If the result of the informal follow-up action, or the severity of the problems encountered during the audit so indicate, a formal visit and another audit will be employed to ensure the successful accomplishment of the prescribed corrective action.

6.5.4 REPORTS OF FOLLOW-UP ACTIONS. Reports of formal follow-up actions or re-audits will be issued in the same manner and general format described in the preceding paragraph 6.4.



Section 7: PARTS, MATERIALS AND COMPONENTS PROGRAM

7.1 GENERAL

This section expands Section 10.5.6 of M-D MA 500, Apollo Program Development Plan, which provides the requirements for the selection of reliable parts, materials, and components in the Apollo Program. The program developed herein, establishes the policy, responsibilities and requirements necessary to ensure the selection, application, and dissemination of information concerning reliable parts, materials and components, throughout the Apollo Program.

7.2 PROGRAM POLICY

a. The Apollo Parts, Materials and Components Program will fully utilize applicable methods, techniques, and systems which currently exist in the Apollo Program.

b. Parts and materials previously proven reliable in other missile and space programs will be selected from preferred parts lists and tested, as necessary, to make certain they are satisfactory for use in the Apollo Program.

c. NASA-wide Part/Material Application Problem Disposition Reports (NASA Form 863) will be used by the Centers and their contractors to ensure that failures already encountered will not be repeated (See NMI 5310.1).

d. All parts selected for Apollo will be inspected 100 percent by the contractor or his subcontractors, except as otherwise provided by the Centers.

e. Parts traceability is used to enable defective parts to be located in the system, should some problem arise. Not all material, parts, assemblies or equipment will require the same depth of traceability. Identification of proposed exempt articles will be documented and submitted, with the reason for exemption, for approval prior to start of procurement or manufacture (See Section 8 of this document).

7.3 RESPONSIBILITY

7.3.1 THE APOLLO PROGRAM OFFICE - R&QA

a. The Apollo Program Office - R&QA will provide direction; coordinate Center, DoD and allied program activities; and support the program activities, as necessary.

b. The Apollo Program Office - R&QA will monitor and review existing Apollo parts programs at Centers to determine compliance with existing procedures and to make recommendations for program improvement.

7.3.2 CENTER APOLLO PROGRAM OFFICES - R&QA. In accordance with the policies stated herein, the Center Apollo Program Offices - R&QA (or designated Center organizations) will:

a. Prepare technical requirements which reflect the parts program elements of paragraph 7.4 below and review and approve contractor parts and materials program plans.

b. Keep the Apollo Program Office - R&QA and other Centers informed of significant events relating to parts program activities. Parts failure information will be disseminated in accordance with the requirements established in NMI 5310.1, Reporting of NASA Parts and Materials Applications Problems.

c. Monitor and audit their in-house and contractors' parts programs.

d. Ensure that their respective parts program participants, either directly or through the Center, provide APIC (paragraph 7.3.3 below) with timely parts/materials information and documentation resulting from program implementation, as outlined in paragraph 7.4. below.

7.3.3 PARTS INFORMATION ACTIVITY. MSFC will be responsible for the operation of the Apollo Parts Information Center, APIC, an activity established at Huntsville for collection, storage and dissemination of parts and materials information, in accordance with M-1 MA 1450.045. Any changes in the APIC activity will be coordinated between the Apollo Program Office - R&QA and APIC management.

7.4 PARTS, MATERIALS, AND COMPONENTS PROGRAM ELEMENTS

7.4.1 GENERAL. The Center Apollo Program Offices - R&QA are responsible to ensure that all Apollo Program organizations implement the Parts, Materials, and Components Program elements defined in the ensuing paragraphs.

7.4.2 PARTS AND MATERIALS SELECTION. Parts will be selected by program participants on the basis of proven qualification for their application(s) as reflected in Center control documentation. In the absence of such documentation, contractors will submit a candidate listing of critical parts/materials to the Center Apollo Program Office - R&QA for review or approval, as directed by the Center. Historical data derived from similar applications will be considered in making selections. "Off-the-shelf" parts will not be used

unless identification and life history are known for the class of item and/or the specific hardware itself, as appropriate (See paragraph 8.3.5).

7.4.3 PARTS STANDARDIZATION. Parts standardization programs will be implemented where possible to minimize the total number of part types in the Apollo Program. Design reviews will include provisions that will check progress in parts standardization.

7.4.4 PARTS AND MATERIALS LISTS. Appropriate parts and material lists, supported by acceptance test data and proven performance, will be developed in accordance with Center control documentation, as required by the cognizant Center. Lists will reflect maximum standardization and multiple application capability. Lists will be submitted for approval when so directed by the cognizant Center.

7.4.5 ADEQUATE SPECIFICATIONS. Adequate specifications will be prepared to define, control, and procure parts and materials in accordance with NPC 500-1 and Center-approved supplements.

7.4.6 QUALIFICATION TESTING. In cases where tests results are not available or parts/materials have not adequately been tested for a specific intended application, a qualification test program will be developed in accordance with the specification requirements. Contractor test programs will be reviewed or approved by the cognizant Center Apollo Program Office - R&QA.

7.4.7 FAILURE ANALYSIS AND REPORTING. A system for the recording, analysis and reporting of all failures that occur will be initiated and implemented. Parts failure information will be disseminated in accordance with NMI 5310.1.

7.4.8 PROCESS CONTROL. An adequate defect prevention program will be maintained to control the manufacturing process of parts and subassemblies. Screening techniques, such as: visual inspection, x-ray, seal leak tests, burn-in, etc., will be utilized to detect defective items. Procedures outlining these manufacturing techniques will be developed in accordance with the cognizant Center's requirements.

7.4.9 INSPECTION. In-process inspection as well as final inspection procedures will be applied. These procedures will be kept current by incorporating new and approved techniques, as appropriate.

7.4.10 PARTS TRACEABILITY. Methods and procedures will be established assuring parts traceability by part number, manufacturer serial number, date or lot code, as appropriate, and location as used in Apollo hardware. This information will be documented and submitted to the cognizant Center (See Section 8 of this document).

7.4.11 DOCUMENTATION. Documentation of the preceding activities will be prepared by the Apollo participants, in accordance with requirements of the cognizant Center.

7.5 APOLLO PARTS INFORMATION CENTER (APIC)

7.5.1 GENERAL. All Apollo participants will support the APIC Program by the timely submission of available parts/materials data, as appropriate, from the activities described in paragraph 7.4 above. The APIC information will be made available to all Apollo participants.

7.5.2 INPUT. The types of parts/materials information available in, and required by APIC, may include:

a. Program parts list by part number

b. Parts/materials test reports

c. Preferred parts/materials list

d. Specifications

e. Failure analysis reports

f. Inspection reports

g. Characteristic data

h. Additional comments as required by par. 7.5.3.

7.5.3 OUTPUT. The primary outputs of APIC may include:

a. Integrated test information

b. Qualification status lists

c. Parts analysis summary sheets

d. Usage factors

e. Availability and status of specifications

f. Failure rates and modes

g. Critical items list

h. Manufacturing and construction techniques

i. Supplier comments

j. Preferred parts and materials

k. Item identifcation

l. Replacement and/or substitute items

m. Inspection and test data, including results of qualification tests.

APIC outputs will be useful to the degree that they reflect timely and adequate input data.

7.5.4 SPECIAL DATA. Special data are those which do not fall within the primary APIC outputs listed above. Apollo program participants will submit all requests for special parts and materials data to MSFC for consideration. MSFC will establish the necessary operational methodology encompassing separate specialized information requirements tailored to a particular user's needs. Additional APIC outputs will be made available to all participants, as appropriate.

Section 8: IDENTIFICATION FOR TRACEABILITY

8.1 GENERAL

This section defines the requirements for establishing and implementing an Identification for Traceability (I/T) Program. The program will enable compliance with NASA quality provisions of NPC 200-2, inspection systems of NPC 200-3 and configuration provisions of NPC 500-1, and be consistent with the logistics provisions of NHB 7500.1 for Apollo space systems and related equipment. These requirements are applicable to all NASA Centers, contractors, subcontractors and suppliers involved in the Apollo Program to: 1) assure the availability of the required historical records and functional data of identified article(s) in order to facilitate failure analysis and corrective action; 2) permit the location of like article(s), and 3) provide complete article retrieval capability.

8.2 APPLICATION

8.2.1 GENERAL. The Center Apollo Program Offices - R&QA are responsible for assuring that all Apollo Program organizations implement the requirements for Identification for Traceability. These requirements will be applied to Apollo space systems, boilerplate test hardware, battleship vehicles, spare parts, and associated ground support equipment meeting any of the following conditions:

a. The equipment, if discrepant, will adversely affect the mission requirements.

b. The equipment, when discrepant, can result in hazardous or unsafe conditions for using or maintenance personnel.

c. The equipment is susceptible to failure or gradual degradation in its system application.

d. The data accumulated during the life of the equipment are necessary for analysis to effect failure recurrence prevention or product improvement.

8.2.2 DETERMINATION. Identification for Traceability will be established on drawings, specifications, and technical documents. The requirements will be established during design and evaluated at design review, and/or may be performed as required at any period subsequent to design review to ensure that identification is introduced at the proper level and that the identification method, type, and location are properly specified.

8.2.3 LIMITATIONS. No statement herein will be interpreted to indicate a waiver to the contractual quality, reliability, configuration, or logistics requirements.

8.3 REQUIREMENTS FOR IDENTIFICATION

8.3.1 CRITERIA FOR ARTICLE IDENTIFICATION. Article identification and the degree of traceability required on equipment which meet any of the conditions of paragraph 8.2 will be established by detailed analysis of the equipment and its component parts. The following criteria will be considered in establishing the need for article identification:

a. Functionally matched sets of hardware requiring selective fits and assemblies.

b. Articles requiring unique data to be recorded, such as: reliability data, in-process variable data under restrained conditions, variable test data, specific environmental testing, X-ray, etc.

c. In-process material subject to time and cycle variations or degradation and limitations.

d. Articles or assemblies subject to time and cycle variations, degradations, limitations, checkouts, calibration, periodic servicing and maintenance, and reinspection.

e. I/T requirements established for lower level articles must be continued through the next higher level of assembly, to the highest degree of traceability required by any of its components.

8.3.2 EXEMPT MATERIAL AND ARTICLE LIST. Not all material or fabricated articles will require identification for traceability. All proposed exempt material or articles will be listed and submitted, with reason for exemption, to the procuring agency for approval prior to the start of procurement or manufacturing. Articles, subassemblies and assemblies may be listed at the highest level of fabrication or assembly, providing they do not contain any components that require I/T.

8.3.3 ENGINEERING DOCUMENTS. The engineering drawing is the primary vehicle for transmitting detailed I/T requirements. The method of identification and the location and type of marking to be used for the article, will be indicated on the drawings, specifications and/or supporting technical or other control documents. (See Exhibits X, XI and XII of NPC 500-1). All changes released for material or articles identified for traceability will indicate an introduction point of effectivity and disposition of the articles in process.

8.3.4 MULTIPLE APPLICATION REVIEW OF COMMON ARTICLES. Any article having the same description and specification that has

application to both flight hardware, man-rated ground support, and/or other equipment will be reviewed to determine if a differential of design, quality, and/or reliability requirement exists. When a higher requirement exists for any of the preceding categories, source or specification control drawings will be generated to: (1) specify the higher requirements, (2) enable positive identification for traceability, and (3) preclude the use of an unidentified article for a space or replacement article, where the higher requirement exists.

8.3.5 COMMERCIAL, *OFF-THE-SHELF IDENTIFICATION. Off-the-shelf or commercial articles for which adequate, detailed drawings are not available due to the proprietary nature of the article and for which identification is required will have specification or source control drawings prepared with identification requirements as specified in paragraphs 8.2, 8.3.1 and 8.3.4.

8.3.6 IDENTIFICATION METHODS. The following are typical methods that will be used to enable traceability of articles through every step of procurement, processing or manufacturing. These methods will provide capability of tracing backward to the material from which fabrication originated and forward to determine the location of like articles within any level of process or assembly.

a. Lot Numbers. Lot numbers may be used to identify materials, articles and/or assemblies when produced in homogeneous groups or through a controlled process.

b. Date Codes. Date codes indicating the date of manufacture may be used on articles made by a continuous or controlled process, also on articles subject to variations or degradation with age.

c. Serial Numbers. Serial numbers will be used on materials, articles, assemblies, or end items where variables data are maintained, and may be used for non-homogeneous articles.

d. Combined Identification Methods. When required by application and usage, various combinations of lot numbers, date codes, and/or serial numbers may be utilized to achieve the required identification for traceability, continuity, and control required by these requirements.

8.3.7 LOCATION OF IDENTIFICATION. When practicable, articles will carry the identification permanently affixed on the exterior of the article. When affixing identification to a particular article is impractical, due to size or effect on function, other means of identification, such as sealed packages, tagging or records of location within a given assembly, may be incorporated.

*This is intended to control the use of regular catalog articles, not identified by specific customer drawing, and to prevent them from being substituted for a qualified article in an assembly or equipment.

a. Articles Composed of Permanently Fastened Components. Articles composed of permanently fastened components that require separate identification will have the identification established on one component with the other components recorded on the article records.

b. Multi-Cavity Molding or Casting. Identification of the article from each specific cavity will be established by a method that will assure traceability to the cavity and the manufacturing lot.

8.3.8 CONTROL OF IDENTIFICATION NUMBERS. Lot numbers and serial numbers will be assigned to specific material and articles in a consecutive manner to prevent use of the same number on articles with the same drawing and/or part number.

a. Raw Material Identification

(1) Identification Requirement. Raw material will be identified by lot and/or serial number, and will be supported by documented laboratory analysis data, including the related melt and/or heat data as required by the material specification.

(2) Maintenance of Identification. Identification will be maintained on the material and records to a point in the manufacturing cycle where a higher level of identification is introduced.

b. Procured Article Identification. Articles will be identified in accordance with the requirements of paragraphs 8.2, 8.2.1, through 8.6.4.

(1) Supplier Identification. Individual supplier will be identified on articles and records in a unique and acceptable manner that will conform to contractor specification or source control drawing requirements.

(2) Supplier multi-plant manufacturing locations will be individually identified on the articles and records to assure traceability, when required. This includes articles supplied to the procuring contractor from other segments, subsidiaries, or affiliates.

c. Fabricated, Processed, and Assembled Article Identification.

(1) Introduction of Identification Method. Identification will be introduced at the proper point in the manufacturing cycle as indicated by design drawings, technical and/or controlled documents. Controls and initiation of actual identification will be performed as required by approved manufacturing procedures.

(2) Control of Split Lots. Each portion of a split lot will have its own specific identification.

(3) Maintenance of Identification. Identification will be maintained on articles and records in a sequential manner to enable rapid traceability back to the original identification and forward to determine the locations of all like articles from the same lot or related split lot.

8.4 NONCONFORMING MATERIAL IDENTIFICATION

8.4.1 GENERAL. Nonconforming material will be required to be identified in accordance with paragraph 8.3 above. In addition, the following specific identification is necessary:

8.4.2 REPAIR AND/OR USE AS IS

a. Nonconforming articles having additional operations performed, different from the normal manufacturing procedure, will have specific identification.

b. Nonconforming articles will be positively identified both on the article and the manufacturing documents. This identification will be maintained throughout the life of the article to assure that additional operations and/or nonconformances are considered in the event of a failure and analysis, and to enable locating the article during subsequent inspections and tests to evaluate its effect on higher levels of assembly.

8.4.3 SCRAP. Serial numbers of articles that are scrapped will be recorded to account for and terminate the use of that specific serial number for like articles. The lot number of scrapped material or articles will be recorded and become part of the permanent traceability record.

8.5 LIMITED-LIFE ARTICLE CONTROL

8.5.1 GENERAL. These provisions establish the identification for traceability requirements for the utilization and control of limited-life articles which do not fully meet design, quality, and/or reliability specifications and must be used where unusual measures are necessary to meet schedules for testing hardware.

8.5.2 APPLICABILITY. These requirements will be applied and implemented on all flight hardware, man-rated equipment, ground support equipment, and spare parts to assure that any articles that do not meet all requirements, are used only for limited test purposes.

8.5.3 IDENTIFICATION FOR TRACEABILITY REQUIREMENTS. It will be required that all articles in the limited-life category that are

used for limited test purposes are identifiable and traceable, and can be removed and replaced prior to final acceptance testing and/or actual flight performance.

a. Identification Method. Identification for traceability will be established on each article by uniquely marking in a manner that will make the article visually outstanding individually and when assembled with other articles. Each higher level of assembly must be marked in a unique manner to identify visually that it contains such an article, up to and including the end item.

b. Identification Records. Records will be established, maintained, and will accompany the articles. The records will specifically identify the articles and the next higher levels of assembly that contain the articles. The records will enable traceability of all articles, so identified, and have a space for recording the removal of each article, and a space to record the identity of each replacement article.

8.5.4 CONDITIONAL RELEASE FOR LIMITED TESTS ONLY. Hardware and/or equipment, containing limited-life articles requiring transfer to another site or location for the performance of limited tests, will not be given final acceptance release.

8.6 DATA AND RECORD REQUIREMENTS

8.6.1 GENERAL. The record system will have the capability of rapid tracing from the highest level of assembly back to the lowest level specified for introduction of I/T and of rapid tracing forward to assure the location of all like materials, articles, or characteristic lot in order to effect the timely removal from the process, assembly, system, or equipment. The related data and records will be adequate to enable analysis of problems to ensure timely and effective corrective action.

8.6.2 DATA REQUEST RESPONSE. Complete data and record retrieval and analysis will be accomplished within a maximum period of 48 elapsed hours from the initial request for information.

8.6.3 RECORD OF RETENTION. Records of I/T articles will be retained for a minimum period of three years after the hardware has been accepted by the customer or as specified by the contract.

8.6.4 PROCURED MATERIAL

a. Purchase Orders and Attachments. Purchase orders will include reference to engineering drawings and documents that require I/T, will include specific instructions relative to data, records, and other information that must accompany the shipment, and will reference the requirements for data and records to be retained by the supplier.

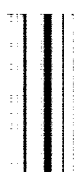
b. Receiving Acceptance. Determination will be made at receiving inspection that all requirements for I/T have been complied with, that all required data and records are complete and adequate, and that the material identified can be related directly to the records.

c. Receiving Records. The receiving record will reference the lot number, date code, and/or serial numbers of each shipment of material or articles.

d. Laboratory Testing. Records resulting from the testing and analysis of material and articles will relate to a specific lot and/or serial number to assure traceability to the fabricated article.

8.6.5 REPLACEMENT OF ARTICLES. The data and record system will provide specific information relative to all removals of articles from assemblies, including: (1) the analysis and corrective action information, (2) the identification and disposition of removed articles, and (3) the identification of all replacement articles.

8.6.6 MANUAL OR MECHANIZED DATA PROCESSING. The data requirements of this document may be implemented by the use of a manual data and record system. A mechanized system may be used in lieu of, or in support of, a manual system. The format and content will be negotiated with the procuring agency.



Section 9: NONCONFORMING MATERIAL CONTROL

9.1 GENERAL

This section provides guidance to NASA installations for the review, control, and disposition of nonconforming material. Users must maintain a continual awareness of the underlying NASA philosophy that defects and nonconformances should be kept to an absolute minimum by means of effective planning throughout the procurement and manufacturing cycle and through the use of effective corrective action systems. These procedures are in no way intended to foster the belief that NASA will accept nonconformances as a normal practice.

9.2 APPLICABILITY

a. Review and disposition of nonconforming material, usually through Material Review Board (MRB) action, are the combined responsibilities of contractor personnel and Government representatives under the direction of the cognizant NASA installation. This section, therefore, amplifies the requirements of applicable sections of NPC 200-2, Quality Program Provisions for Space System Contractors, NPC 200-1A, Quality Assurance Provisions for Government Agencies and, when MRB is specifically authorized by the contract, paragraph 3.8 of NPC 200-3, Inspection System Provisions for Suppliers of Space Materials, Parts, Components, and Services.

b. Where any conflict exists between this section and specific requirements of the contract, the contract shall apply. Similarly, a letter of delegation to a Government Agency will take precedence in case of a conflict with provisions of this section.

9.3 MATERIAL REVIEW BOARD MEMBERSHIP

9.3.1 GENERAL. Each Material Review Board will be composed of one contractor representative whose primary responsibility is design, one contractor representative whose primary responsibility is product quality, and one Government representative actong on behalf of the cognizant NASA installation. There may be alternates for each Board member. The selection of Government Agency Board members shall be subject to disapproval by the cognizant NASA installation, NASA representative, or the delegating agency. Similarly, the NASA installation or its delegated representative will have the right of disapproval of contractor members. Resumes, showing the qualifications of all Government and contractor Board members, will be submitted, as directed, to the cognizant NASA

installation or to the resident NASA respresentative in the contractor's plant. Where MRB authority has been delegated to a Government Agency, copies of the resumes of contractor representatives will be furnished to the Agency.

9.3.2 QUALIFICATIONS AND DUTIES. Members of a Material Review Board will be selected on the basis of technical competence to make decisions and commitments necessary to achieve effective preventive and corrective action and appropriate disposition of the articles involved. Qualifications of each member should enable him to perform as a minimum the specific duties described below:

a. The Design Representative will have a thorough knowledge of the design requirements of the article and be able to appraise accurately the effect of the nonconformance on those requirements. He will also be responsible for initiating any corrective action falling in the area of design change.

b. The Contractor Quality Representative will be responsible for obtaining an analysis of the nonconformance as to probable cause and shall also assure the initiation and control of all necessary corrective action. He will assure that the Board receives a complete and accurate description of the nonconformance in a documented form together with recommendations for disposition.

c. The Government Quality Representative will pursue an independent investigation of the nonconformance including the probable cause, needed corrective action, and the possible disposition alternatives. For a complete list of the duties of the Government Quality Representative on the MRB, see paragraph 3.6.2 of NPC 200-1A.

9.4 PROCEDURE

The sequence of material review actions, as described below, are shown in flow chart format in Figure 9-1.

9.4.1 IDENTIFICATION AND ISOLATION. When material is first found to depart from specified requirements, it will be properly identified as nonconforming for purposes of disposition, and where practical, isolated from normal channels of fabrication and processing.

9.4.2 INITIAL REVIEW BY CONTRACTOR. All nonconforming material or articles will be reviewed initially by contractor quality personnel (and engineering personnel as deemed necessary). This contractor review will result in one of the following actions:

a. Scrap. If the material is obviously unfit for use, it may be scrapped in accordance with the contractor's procedure for

identifying and disposing of scrap. Such procedures should give consideration to any special contract restrictions concerning the scrapping of Government furnished material or material acquired on cost plus fee contracts. Consideration should be given to alternative uses of the scrapped article for contractor training programs, engineering laboratory work, etc., in order to minimize the financial loss resulting from scrap dispositions.

b. Rework or Complete to Drawing. If the material is found to be incomplete or lacking operations, it may be returned for completion or reworked using normal operations not requiring additional written procedures. Following such rework, the material will be resubmitted to normal contractor inspection and/or test operations.

c. Repair. If correction of the nonconformance can be accomplished with specific repair procedures previously approved by MRB, such repair may be authorized and performed. Following such repair, the material will be resubmitted to normal contractor inspection and/or test operations, and to MRB for disposition.

d. "Use As Is." All nonconformances after initial contractor review, are generally submitted to MRB except for rework or scrap. However, when a contractor demonstrates quality controls which continually result in a presentation of conforming material for Government acceptance he may be contractually authorized to make "use as is" dispositions of occasional nonconformances without formal MRB action. These nonconformances which, in the judgment of the contractor's design and quality representatives, are not of sufficient significance to warrant rework or repair and will not have adverse influence on the usability, performance, durability, reliability, interchangeability, or safety of the product may be authorized by contract for "use as is." Such authorizations are subject to periodic review by the cognizant Government Agency or NASA installation. Articles dispositioned under these provisions will be identified as nonconforming in accordance with regular MRB procedures.

e. Submit to Material Review Board. When the contractor decides that the defective article or material should not be scrapped and the conditions for rework, repair, or "use as is" described above, can not be satisfied, the article or material should be submitted to a Material Review Board. Articles submitted for material review action will be identified with an MRB number and routed to holding areas, mutually acceptable to the contractor and the Government representative, unless removal to such an area is impractical due to size or configuration. In either case, marking and/or tagging will be accomplished in a positive manner to assure identification as nonconforming.

9.4.3 MATERIAL REVIEW BOARD ACTIONS

a. As nonconformances are presented for material review, the Board will:

(1) Evaluate all material submitted.

(2) Determine or recommend disposition such as scrap, repair, or "use-as-is" (see paragraph 9.4.5 for details of these disposition alternatives), or exercise the option of recommending disposition to the Contracting Officer.

(3) Approve the method and procedure for repair when such is required.

(4) Provide results of MRB evaluation and recommendations (including proposed repairs) to the Contracting Officer when his approval is required (See paragraph 9.4.6 for details).

(5) Assure that nonconformances requiring Contracting Officer actions are acted upon as directed by the Contracting Officer.

(6) Assure that the supplier accomplishes disposition determined by MRB and initiates prompt and effective corrective action on nonconformances to prevent recurrence.

b. In addition to actions on individual nonconformances, the MRB will:

(1) Periodically review records of nonconformances to determine the supplier's performance and overall effectiveness of his corrective action system.

(2) Maintain records in such a manner as to show recurring discrepancies relative to individual MRB action.

9.4.4 MRB RULES OF PROCEDURE

a. A decision by the Board to accept a nonconforming article "as is" or that repair be attempted requires the concurrence of all three members. It is not mandatory that all members meet concurrently in order to reach a decision, although any member may require the entire Board to convene. Members of the Board may call upon other supplier or Government personnel to act in a non-voting advisory or consultant capacity.

b. In considering alternative dispositions or recommendations, the Board will review records of earlier MRB actions affecting the same article or material and the possible cumulative effect of those actions.

c. Actions and decisions of the Board should be based on considerations of the technical aspects of each nonconformance. The severity and importance of each nonconformance should be reviewed using such criteria as failure effects and criticality analyses performed during the design phase and the mandatory characteristics listing as prepared by the cognizant Government Agency or NASA installation.

9.4.5 MRB DISPOSITION. Following are detail considerations for three (3) of the four (4) options possible through MRB action:

a. "Use As Is" Disposition. Nonconforming material determined to be usable "as is" will be identified as nonconforming with the MRB number, so that a re-evaluation as to the effect on higher levels of assembly may be made at later assembly, inspection, and test points.

b. Repair Disposition

(1) Nonconforming material which, in the opinion of the Material Review Board, can be made acceptable by repair under existing approved processes or assembly procedures previously authorized by the MRB action for that application will be so repaired. Where special techniques appear to offer the possibility of satisfactory repair, disposition may be delayed while the contractor develops and documents the repair technique and obtains approval of the Board.

(2) Repaired articles will be reinspected by the contractor and Government Agency personnel to the standards established by the approved repair procedure. All paperwork related to acceptable repaired articles will be forwarded to the cognizant Material Review Boards to insure continuity of records. Unacceptable repaired articles and their related paperwork will be resubmitted to the Board for disposition. Material which has received a repair disposition will be identified by MRB number to permit re-evaluation as to the effect of the repair on higher levels of assembly.

c. Scrap Disposition. When the Board determines that the nonconforming material cannot be accepted "as is," nor satisfactorily repaired, it will be dispositioned scrap (See paragraph 9.4.2a for consideration of alternative uses of scrapped articles).

9.4.6 MATERIAL DISPOSITION BY CONTRACTING OFFICER

a. The fourth option of the MRB is to recommend that the Contractor request disposition by the Contracting Officer. These dispositions are:

(1) Repair which is so extensive or time consuming that contract cost or delivery schedule will be affected. Authority for such a repair must be obtained prior to initiation of work.

(2) Waiver of requirements by acceptance of articles containing nonconformances that could, in the judgment of qualified personnel, result in:

(a) Harzardous or unsafe conditions for individuals using or maintaining the contractual end item into which the article is to be installed, or,

(b) Adverse effect on reliability, durability or performance of the contractual end item or,

(c) Adverse effect on interchangeability requirements or,

(d) Adverse effect on weight when the weight of the nonconforming article is a critical factor and the repair adversely affects this individual weight requirement.

b. The terms "major" and "minor" are commonly used by both industry and Government Agencies to differentiate between nonconformances of greater or lesser importance. Major nonconformances would be as defined above, paragraph 9.4.6a(2). Nonconformances which do not affect the above four elements are classed as minor and are handled through contractor procedures or by Material Review and Board action.

c. Under certain circumstances, a repair disposition may be made by the Material Review Board on a nonconformance which when initially discovered, would normally require waiver action by the Contracting Officer. When it is the opinion of the Board that repair will restore the article to a usable condition with the nonconformance then being of a minor nature, and the repair is not so extensive that contract cost or schedule will be affected, the repair may be made without referral to the Contracting Officer. In such cases, the Board will conduct a post-repair review.

9.4.7 DESIGN RESPONSIBILITY RETAINED BY NASA OR CONTRACTOR. In those instances where the procuring NASA Center has design responsibility and authority, the contractor design representative must coordinate all engineering decisions with the responsible NASA Center design group. Similarly, subcontractor design representatives must coordinate all engineering decisions with the responsible contractor design group.

9.5 DOCUMENTATION AND RECORDS

9.5.1 GENERAL. Records of all nonconformances and their dispositions will be maintained by the supplier and be provided or made available to local NASA or Government agency representative, upon request. In addition, all records of MRB actions will be maintained by the supplier and be provided or made available to local NASA or

Government agency representative, upon request. In addition, all records of MRB actions will be maintained and available for ready reference. Forms and records used to document MRB actions will be those of the supplier and will contain the following information as a minimum:

(a) A unique and traceable MRB report number on each form.

(b) A complete description of the nonconformance identified to an MRB report number.

(c) The identification drawing number and lot number, serial number or date code of the nonconforming article(s) in accordance with paragraph 8.4.

(d) A reference to documented repair procedures, as applicable.

(e) Classification of the nonconformances (Contracting Officer's action required/not required).

(f) Signature or stamp of person originating the report.

(g) The corrective action implemented to eliminate the cause of the discrepancy.

(h) The disposition of the nonconforming article.

(i) The authorizing signatures of the Material Review Board members.

9.5.2 CONTRACTING OFFICER ACTION. Nonconformances requiring action by the Contracting Officer will be documented on forms indicating the recommendations of the contractor and the local NASA or Government Agency representative. Space will also be provided for indicating Contractor Officer approval or disapproval of the request for action.

9.5.3 NONCONFORMANCE ACTION SUMMARIES. A summary of nonconformances and the resulting dispositions will be prepared and periodically updated by the contractor. The summary should also include a tabulation in such a form as to show recurring discrepancies. This summary will be a part of the data reporting and corrective action system as required by Section 14 of NPC 200-2 or Paragraph 3.14 of NPC 200-3. The purpose of this summary will be to facilitate a review of past nonconformances and to audit the actual implementation of planned corrective action resulting from those nonconformances.

9.5.4 DD FORM 250. All departures from contractual acceptance requirements will be included in the DD-250, in accordance with Exhibit XI of NPC 500-1.

9.6 SUBCONTRACTOR MRB

This section also provides guidance for contractors to whom MRB responsibility is delegated. The contractor will limit the authority of the subcontractor's MRB dispositions to nonconformances not requiring waiver action (See paragraph 9.4.6). Where the NASA installation has delegated MRB authority to a Government Agency at the contractor's facility, the Agency may be authorized to redelegate MRB authority to the Government Agency at a subcontractor's location.

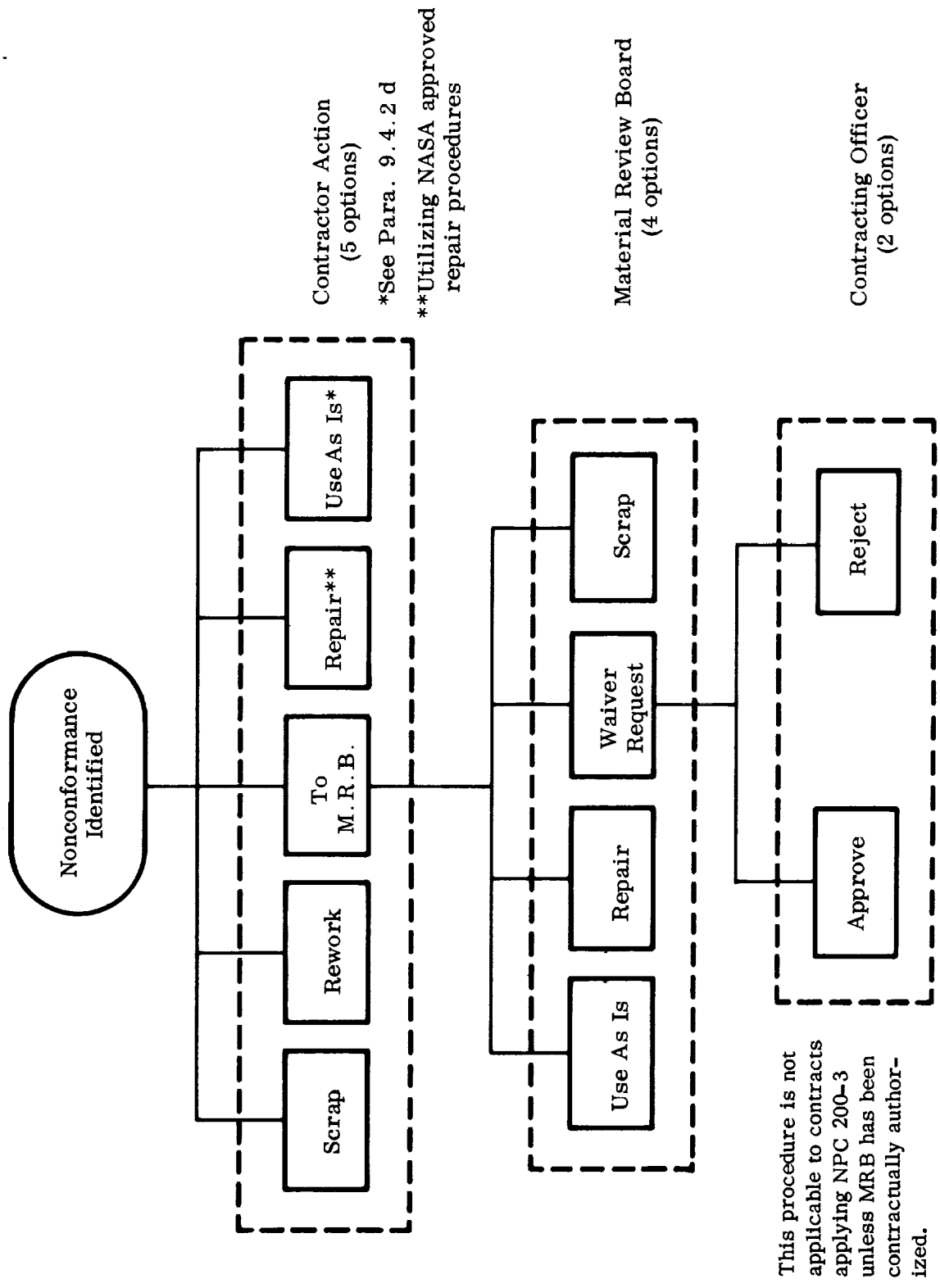
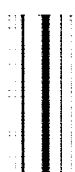


FIGURE 9-1. ACTION SEQUENCE FOR NONCONFORMING MATERIAL DISPOSITION



APPENDIX A
REFERENCE DOCUMENTS

The following NASA documents are pertinent to this publication. Some may not be specifically referenced herein, but are listed, nevertheless, because they provide the basic authority for management of, or have technical impact on, the Apollo Program.

NMI 4-1.1	Planning and Implementation of NASA Projects, March 8, 1963.[1]
NMI 1052.12	NASA - Air Force Agreement relating to R&D Procurement and Field Service Functions, September 15, 1960.[1]
NMI 1052.15	NASA - Navy Agreement for Performance of Field Service Functions, March 1, 1962.[1]
NMI 1052.18	Department of the Army - NASA Agreement for Performance of Procurement Administration Functions, August 1, 1960.[1]
NMI 1052.38	DoD - NASA Agreement for Contract Administrative Services for NASA, Revised January 15, 1965.[1]
NMI 5310.1 Alert	Reporting of NASA Parts and Materials Application Problems, February 15, 1964.[1]
NMI 5320.1	Reliability Policy as Applied to NASA Programs, February 1, 1961.[1]
NMI 5330.1	Quality Assurance Policy as Applied to NASA Programs, October 13, 1961.[1]
NMI 5330.2	Quality Status Stamping Requirements, August 30, 1963.[1]
NMI 5330.4	Policies and Procedures for Recertification of Hand Soldering Personnel, December 21, 1964.[1]
NMI 5330.5	Policies and Procedures for Training and Certification of Personnel for Fabrication and Inspection Processes, June 29, 1965.[1]
NMI 8020.3A	Manned Space Flight Flash Reports, November 10, 1965.[1]

NHB 5300.2	Apollo Metrology Requirements Manual, December 1965.[1]
NHB 5320.2	Manual for Evaluating Apollo Contractor Reliability Plans and Performance, June 1965.[1]
NHB 7500.1	Apollo Logistics Requirements Plan, November 1965.[1]
NPC 107	NASA Basic Administrative Processes, February 1964 Edition.[1]
NPC 200-1A	Quality Assurance Provisions for Government Agencies, June 1964 Edition.[2]
NPC 200-2	Quality Program Provisions for Space System Contractors, April 1962 Edition.[2]
NPC 200-3	Inspection Provisions for Suppliers of Space Materials, Parts, Components and Services, April 1962 Edition.[2]
NPC 250-1	Reliability Program Provisions for Space System Contractors, July 1963 Edition.[2]
NPC 400	NASA Procurement Regulations, January 1964.[2]
NPC 500-1	Apollo Configuration Manual, May 18, 1964.[1]
NPC 500-6	Apollo Documentation Administration Instruction, August 1, 1964.[1]
NPC 500-7	Apollo Documentation Index (Latest Edition).[1]
NPC 500-10	Apollo Test Requirements, May 20, 1964.[1]
SE 005-001-1	Apollo Program Specification, April 1965.[1]
M-D E 8000.005	Apollo Flight Mission Assignments (Latest Edition).[1]
M-D E 8020.008	Natural Environment and Physical Standards Specification, April 1, 1965.[1]
M-D MA 500	Apollo Program Development Plan, January 1966.[1]
M-D MA 1400.006	Apollo Program Directive No. 6, "Sequence and Flow of Hardware Development and Key Inspection, Review and Certification Checkpoints", August 12, 1965.[1]

M-D MA 2210.008	Apollo Program Directive No. 8, "Flight Readiness Review, November 8, 1965.[1]
M-D MA 1400.036	Apollo Program Directive No. 19, "Apollo Flight Evaluation Requirements", June 6, 1966.[1]
M-I MA 1450.045	Delegation of Apollo Parts Information Activity Responsibility to Marshall Space Flight Center, February 2, 1965.[1]
M-I MP 9320.044	Preparation and Revision of Program/Project Development Plans (PDP's), February 16, 1965.[1]
92-900-000	NASA Projects Approval Document, Research and Development, Apollo (Latest Edition).[1]
SP-6001	Apollo Terminology, August 1963.[3]
SP-6003	Quality Program Evaluation Procedures, September 1963.[3]
RA 006-007-1	Apollo Reliability Estimation Guidelines, June 1966.[1]

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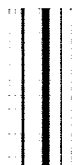
[1] Available from the Center Administrative Distribution Point.
[2] Available from the Center Administrative Distribution Point for all NASA activities and from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402 for all contractors.
[3] Available from the Scientific and Technical Information Division (Code USS), National Aeronautics and Space Administration, Washington, D.C. 20546.



APPENDIX B
LIST OF ABBREVIATIONS AND CODES

ACE	Acceptance Checkout Equipment
ADAI	Apollo Documentation Administration Instruction
ADI	Apollo Documentation Index
APIC	Apollo Parts Information Center
ATR	Apollo Test Requirements
CDR	Critical Design Review
CM	Command Module
COFW	Certification of Flight Worthiness
DCR	Design Certification Review
DoD	Department of Defense
EMI	Electromagnetic Interference
ESE	Electrical Support Equipment
FACI	First Article Configuration Inspection
FLARE	Flight Anomalies Reporting
FMECA	Failure Mode, Effects and Criticality Analysis
FRR	Flight Readiness Review
GA	Government Agency
GOSS	Ground Operational Support System
GSE	Ground Support Equipment
KSC	Kennedy Space Center
LC	Launch Complex
LM	Lunar Module
LV	Launch Vehicle
M	Office of Associate Administrator for Manned Space Flight
MA	Apollo Program Office
MAO	Apollo Program Office - Flight Operations
MAP	Apollo Program Office - Program Control
MAR	Apollo Program Office - R&QA
MAS	Apollo Program Office - Systems Engineering
MAT	Apollo Program Office - Test
MLL	Manned Lunar Landing
MRB	Material Review Board
MSC	Manned Spacecraft Center
MSE	Mechanical Support Equipment
MSF	Manned Space Flight
MSFC	Marshall Space Flight Center
NASA	National Aeronautics and Space Administration
NHB	NASA Handbook
NMI	NASA Management Instruction
NPC	NASA Publication Control (Number)
OMSF	Office of Manned Space Flight
PAD	Project Approval Document
PDP	Program/Project Development Plan
PDR	Preliminary Design Review
PR	Procurement Regulations
R&D	Research and Development
R&Q	Reliability and Quality
R&QA	Reliability and Quality Assurance
RFI	Radio Frequency Interference
RFP	Request for Proposals
SC	Spacecraft
SM	Service Module
SP	Special Publication
UCR	Unsatisfactory Condition Report

APPENDIX C
GLOSSARY OF TERMS

The reference in the parenthesis after each definition indicates the source document(s) from which the definition wording was taken. Where no such reference is indicated, the definition was developed specifically to fit the needs of this document.

The documents used as sources for this glossary were as follows:

- SP-6001, Apollo Terminology
- NPC 200-2, Quality Program Provisions for Space System Contractors
- NPC 250-1, Reliability Program Provisions for Space System Contractors
- NPC 500-1, Apollo Configuration Management Manual
- RA 006-007-1, Apollo Reliability Estimation Guidelines

ABORT. Premature termination of a mission because of existing or imminent degradation of mission success accompanied by the decision to make safe return of the crew the primary objective. (RA 006-007-1)

ACCEPTANCE. The act of an authorized representative of the Government by which the Government assents to ownership by it of existing and identified articles, or approves specific services rendered as partial or complete performance of the contract. (NPC 200-2)

ALTERNATE MISSION. Deviation from the nominal mission plan, to pursue a substitute or modified set of primary and secondary mission objectives within the anticipated capacity of the system. (RA 006-007-1)

ANOMALY. Any irregularity recognized in flight operations.

APPORTIONMENT. See Reliability Apportionment.

ARTICLE. A unit of hardware or any portion thereof required by the contract. (SP-6001, NPC 200-2)

ASSEMBLY. A number of parts or subassemblies or any combination thereof joined together to perform a specific function. (RA 006-007-1)

ASSESSMENT. See Reliability Assessment.

AUDIT. A generic term indicating a formal examination of existing R&QA activities. Day-to-day and week-to-week monitoring action is not classed as a formal audit.

CHARACTERISTIC. Any dimensional, visual, functional, mechanical, electrical, chemical, physical, or material feature or property; and any process-control element which describes and establishes the design, fabrication, and operating requirements of an article. (NPC 200-2)

COGNIZANT NASA INSTALLATION. That major organizational unit of NASA which has direct technical and managerial responsibility for the system under contract. (NPC 250-1)

COMPONENT. A part, assembly, or combination of parts, subassemblies, or assemblies, usually self-contained, which performs a distinctive function in the operation of the overall equipment. A "black box". (NPC 200-2, NPC 250-1)

CONDITIONAL RELEASE. Allows the processing of hardware or equipment with only partial performance to requirements and requires stipulation of additional requirements that must be completed before acceptance as a complete performance to contract.

CONFIGURATION. The technical and physical description required to fabricate, test, accept, operate, maintain and logistically support systems or equipment. (NPC 500-1)

CONTRACT. The contractual agreement formally executed by the Government and the prime contractor which requires performance of services and/or delivery of a product at a cost to the Government, in accordance with terms and conditions set forth therein, and which, in addition to the terms and conditions thereof, includes by reference or otherwise, specifications, drawings, exhibits, and other data necessary to its proper performance. (NPC 200-2, NPC 250-1)

CONTRACT SCHEDULE. That portion of a Government prime contract which describes the articles or services desired for that particular contract. Not to be confused with contract time-schedule or delivery schedule. (NPC 200-2)

CONTRACTOR. "Contractor" means any person, partnership, company or corporation (or any combination of these) which is a party to a contract with the United States. (NPC 250-1)

CREW SAFETY. Safe return of all crew members whether or not the mission is completed. (RA 006-007-1)

CRITICAL FAILURE. Any failure which results in loss of life and/or which results in mission loss or abort. (NPC 500-10)

CRITICAL PART. A part, the failure of which will result in loss of life and/or will result in mission or abort (NPC 500-10)

DATE CODE. A number which indicates a specific date in code. A date code may consist of a series of numbers that indicate day, week, month, or year.

DEFECT. Any conconformance of the unit of product with specified requirements. (SP-6001)

DEGREE OF TRACEABILITY. The depth to which the retrievable records shall be capable of verifying the identity of an article or lot of articles.

DESIGN SPECIFICATION. A document prescribing criteria to be satisfied in designing a particular component, subsystem, or system (or part). Typical criteria include performance requirements under specified environments,

interface requirements, size, weight, ruggedness, safety margins, derating factors, and apportioned reliability goal (with definition of failure). (NPC 250-1)

DESIGNATED REPRESENTATIVE. An individual (such as a NASA plant representative), firm (such as an assessment contractor), or Government Agency designated and authorized by NASA to perform a specific function(s) relative to the contractor's reliability effort; e.g., monitorship, assessment, design review participation, and/or approval of certain documents or actions. (NPC 250-1)

DEVIATION. A specific authorization, granted before the fact, to depart from a particular requirement of specifications or related documents. (NPC 200-2)

DISCREPANCY. See Defect.

DISPOSITION. The documented decision to rework or repair a specific nonconformance on the specific article(s), or to accept for use the article(s) containing a specific nonconformance or to scrap or otherwise disallow the use of the article in its intended application.

END ITEM. A space system or any of its principal system or subsystem elements, e.g., launch vehicle, spacecraft, ground support system, propulsion engine, or guidance system. Also, articles covered by major subcontracts where NPC 200-2 is invoked by the NASA installation or by a system prime contractor. Also, articles which will be delivered direct to a Government installation or provided as GFP to a contractor. (NPC 200-2)

EQUIPMENT. One or more assemblies, or a combination of items, capable of performing a complete function. (SP-6001)

FAILURE. The proven inability of a system, sub-system, component or part to perform its required function during test, operation or end use. (SP-6001)

FAILURE ANALYSIS. The study of a specific failure, which has occurred, in order to determine the circumstances that caused the failure and to arrive at a course of corrective action that will prevent its recurrence. (NPC 250-1, RA 006-007-1)

FAILURE MODE, EFFECT AND CRITICALITY ANALYSIS.

- FAILURE MODE ANALYSIS. The study of a space system and working interrelationships of the parts thereof under various anticipated conditions of operation (normal and abnormal) to determine probable location and mechanism, by which failures will occur. (NPC 250-1).

- FAILURE EFFECT ANALYSIS. Study of the potential failures which might occur in any part of a space system to determine the probable effect of each on all other parts of the system and on probable mission success (NPC 250-1).

- FAILURE CRITICALITY ANALYSIS. Study of the potential failures which might occur in any part of a space system in relation to other parts of the system to determine the severity of effect of each failure in terms of a probable resultant safety hazard, unacceptable degradation of performance, or loss of mission of a space system. (NPC 250-1)

FLIGHT ASSURANCE TEST. A test or series of tests to ascertain that an item of flight hardware meets specified environmental and performance criteria established to confirm that the specimen in question is flight-worthy. Flight assurance tests are conducted at the component, subsystem or system level on specimens of hardware which have not been previously subjected to severe test or handling treatments, but which are identical to the qualification test specimens in all physical respects and in the methods and controls used in their fabrication. (NPC 250-1)

HARDWARE. The physical objects, as distinguished from their capability or function. (SP-6001)

HUMAN ERROR. An human action that is outside previously established criteria of acceptability, or is based on an incorrect interpretation of a set of factors. (RA-006-007-1)

HUMAN-INDUCED FAILURES. Failures attributable to non-compliance of personnel to accepted and/or authorized procedure, either by omission or commission, such as improper maintenance, handling, storage, preservation, etc.; insufficient or improper direction; lack of safety precautions; negligence; ignorance; or sabotage.

IDENTIFICATION (For Traceability). A controlled serial, lot number, date code, or combined serial and lot number or date code which relates the article, assembly, model, or system to a particular lot of raw material, process, manufacturing data, cure date, receiving date, purchased lot, historical record, inspection or test data, calibration data, assembly process, matched articles, expiration date, operating time, X-ray, or other pertinent data.

INSPECTION. The examination, including testing, of contract work, articles, and services to determine conformance to contract requirements. (NPC 200-2)

INSPECTION AGENCY. A Government Agency, or an agency acting on behalf of the Government, to determine that contracted articles and services conform to technical requirements. (NPC 200-2)

INTERFACE. The junction points or the points within or between systems or subsystems where matching or accommodation must be properly achieved in order to make their operation compatible with the successful operation of all other functional entities in the space vehicle and its ground support. (NPC 200-2)

LAUNCH AVAILABILITY. The probability of the space vehicle meeting a specified launch window. (RA 006-007-1)

LIMITED LIFE ARTICLES. All articles having a known degradation, deviation, nonqualified for the application, and/or are being used for development of a new design or for experimental purposes.

LIMITED TESTS. Those test performed using limited life articles, performed prior to final acceptance and release.

LOT NUMBER. A number which identifies raw material or a group of articles that are produced concurrently and are identical in every respect.

MAINTAINABILITY. The quality of the combined features of equipment design and installation that facilitates the accomplishment of inspection, test, checkout, servicing, repair, and overhaul with a minimum of time, skill, and resources in the planned maintenance environments. (NPC 200-2, NPC 250-1)

MAJOR COMPONENT. A component whose reliability is considered particularly critical to the reliability of the subsystem or system in which it is used and which is designated as a major component in the approved Reliability Program Plan for the contract. (NPC 250-1)

MAJOR SUBCONTRACT. A subcontract (regardless of tier) for procurement of a major component (or subsystem, or system) and so identified in the Reliability Program Plan. (NPC 250-1)

MALFUNCTION. Failure of a product to give satisfactory performance. (SP-6001)

MANUFACTURING PROCESS. The equipment, tooling and methods that the manufacturer intends to use in production. (SP-6001)

MATERIAL REVIEW BOARD (MRB). A formal Contractor-Government board established to determine or recommend the disposition of nonconforming articles or material. One or more MRB's may be established as demanded by volume and diversity of operations.

MODEL. An analytic or physical analogue or representation of the system having the property that operations with the model duplicate those with the system in the characteristics of interest. (RA-006-007-1)

MILESTONE. Any significant event in the design and development of a space system or in the associated reliability program which is used as a control point for measurement of progress and effectiveness or for planning or redirecting future effort. Reliability program milestones should be identified in the Reliability Program Plan. (NPC 250-1)

MISSION PROFILE. A graphic or tabular presentation of the flight plan of a spacecraft showing all pertinent events scheduled to occur. (SP-6001)

MISSION RELIABILITY PROFILE. A graphic or tabular description of the nominal and contingent mission flight plan showing the occurrence of scheduled events, their sequence and duration, the environments expected to be encountered, and other parameters describing the mission. (RA 006-007-1)

MISSION SUCCESS. The attainment of all major objectives of the mission as defined in the mission and flight directive with no crew fatality. (RA 006-007-1)

NASA'S DESIGNATED REPRESENTATIVE. A representative of the NASA installation stationed at the supplier's plant or a representative of the inspection agency to whom quality assurance functions have been delegated. (NPC 200-2)

NASA INSTALLATION. A major organizational unit of the NASA; includes Headquarters and field installations. Field installations are assigned specific missions in the NASA space program. (NPC 200-2)

NONCONFORMANCE. A condition of any material, part, or product in which one or more characteristics do not conform to the specified requirements.

PART. One piece, or two or more pieces joined together, which are not normally subject to disassembly without destruction of designed use. (NPC 200-2, NPC 250-1)

PREDICTION. See Reliability Prediction.

PROCURING INSPECTION AGENCY. Inspection agency at the plant of the supplier placing a subcontract. (NPC 200-2)

QUALIFICATION. Determination by a series of tests and examinations of documents and processes that a part, component, subsystem, or system is capable of meeting performance requirements prescribed in the purchase specification or other documents specifying what constitutes adequate performance capability for the item in question. (NPC 250-1)

QUALIFICATION DATA. The complete body of data obtained in the qualification testing of a part, component, subsystem or system. (NPC 250-1)

QUALIFICATION TEST. A test or series of tests conducted to determine whether a part, component, subsystem, or system meets qualification requirements. (NPC 250-1)

QUALITY ASSURANCE. A planned and systematic pattern of all actions necessary to provide adequate confidence that the end items will perform satisfactorily in actual operations. (NPC 200-2)

QUALITY CONTROL. A management function to control the quality of articles to conform to quality standards. (NPC 200-2)

QUICK FIX. A repair made, usually on the spot, to correct a failure in test or in the field which makes the equipment different in some degree from its original design. (NPC 250-1)

RECORDS. Documented data and information relative to source control, procurement, stock, storage, manufacturing, process control, inspection, test, and shipping.

RECURRENCE CONTROL ACTION. The corrective action taken to preclude or minimize the possibility of failure in follow-on hardware by correcting failure causes.

REDUNDANCY (of Design). The use of more than one means of accomplishing a given task or function where all must fail before there is an over-all failure of the system. (NPC 250-1)

REDUNDANCY (of Effort). Duplication or extensive overlapping of effort. (NPC 250-1)

RELIABILITY. The probability that a system, subsystem, component, or part will perform its required functions under defined conditions at a designated time and for a specified operating period. (NPC 200-2, NPC 250-1)

RELIABILITY APPORTIONMENT. The assignment (by derivation from the contractual reliability requirement) of reliability goals to systems, subsystems, and components within a space system which will result in meeting the over-all contractual reliability requirement for the space system if each of these goals is attained. (NPC 250-1)

RELIABILITY ASSESSMENT. An analytical determination of numerical reliability of a system or portion thereof. Such assessments usually employ mathematical modeling, use of directly applicable results of tests on system hardware, and some use of estimated reliability figures. (NPC 250-1)

RELIABILITY DEMONSTRATION. Statistically designed testing, with specifield confidence level, to demonstrate that an item meets the established reliability requirement. (NPC 250-1)

RELIABILITY ESTIMATION. A determination of the reliability of a system or portion thereof utilizing either direct measurement or modeling techniques and appropriate apportionment, prediction, or assessment data. (RA 006-007-1)

RELIABILITY LOGIC DIAGRAM A network depicting the success paths associated with specific equipment operating during a defined mission subphase to perform a required function. (RA 006-007-1)

RELIABILITY PREDICTION. An analytical estimation of numerical reliability of a system or portion thereof similar to a reliability assessment, except that the prediction is normally made in the earlier design stages where very little directly applicable test data is available. (NPC 250-1)

REMEDIAL ACTION. The action to restore an item of equipment to operational status.

REQUALIFICATION. Repetition of qualification testing of an item using new test specimens to determine whether the item still meets qualification requirements. Usually conducted after a design or material change in the item or when there is reason to doubt that it is still representative of the item originally qualified. (NPC 250-1)

REQUEST FOR PROPOSAL (RFP). A formal request from NASA to prospective contractors to submit proposals or bids on a prospective contract. (NPC 250-1)

SERIAL NUMBER. A number which identifies individual articles, assemblies, and equipment.

SINGLE FAILURE POINT. A single item of hardware which, if it fails, would lead directly to loss of life or loss of mission.

SOFTWARE. Activities, such as studies, analyses, reviews, services and documentation relating to both the physical objects (hardware) and their capabilities and functions.

SOURCE CONTROL DRAWING. A drawing that identifies the supplier and part number, tested and approved for use in specific equipment. Eliminates substitution of the item without prior testing and approvals. (SP-6001)

SOURCE INSPECTION AGENCY. Inspection agency at the plant of the actual producer of the purchased articles. (NPC 200-2)

SPACE SYSTEM. A system of equipment consisting of launch vehicle(s), spacecraft, ground support equipment, and test hardware, used in ground testing launching, operating and maintaining space vehicles or spacecraft. (NPC 200-2, NPC 250-1)

SPACE VEHICLE. A launch vehicle and its associated spacecraft. (NPC 200-2)

SPECIFICATION CONTROL DRAWING. A drawing that specifies the configuration, design, and test requirements for the item; designed and manufactured by suppliers.

SUBCONTRACT. A formal contract between a prime contractor to the Government and another concern or individual(s) (first tier subcontract) requiring performance of services and/or delivery of a product required in connection with the prime contract, or a similar contractual agreement between a first tier subcontractor and another concern (second tier), etc. (NPC 200-2, NPC 250-1)

SUBCONTRACTOR. A concern or individual(s) entering into a contract with the prime contractor or with a subcontractor in a tier higher than his own for services or a product required for the prime or a subcontract. (NPC 200-2, NPC 250-1)

SUPPLIER. A contractor, subcontractor or other source producing or providing articles or services required in connection with the prime contract. (NPC 200-2, NPC 250-1)

SYSTEM. One of the principle functioning entities comprising the project hardware and related operational services within a project or flight mission. Ordinarily, a system is the first major subdivision of project work. Similarly, a subsystem is a major functioning entity within a system. (A system may also be an organized and disciplined approach to accomplish a task, e.g., a failure reporting system.) (NPC 200-2, NPC 250-1)

SYSTEMS INTEGRATION. The management process by which the systems of a project (for example, the launch vehicle, the spacecraft, and its supporting ground equipment and operational procedures) are made compatible, in order to achieve the purpose of the project or the given flight mission. (NPC 200-2)

TRACEABILITY. The ability to trace the history, application, use, and location of an individual article or characteristic lot of articles, through use of the recorded identification numbers.

UNSATISFACTORY CONDITION. Any nonconformance to requirements, procedures or accepted standards, including defects and failures.

WAIVER. Granted use or acceptance of an article which does not meet specified requirements. (NPC 200-2)

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